Vol 17, No. 8 August, 1961

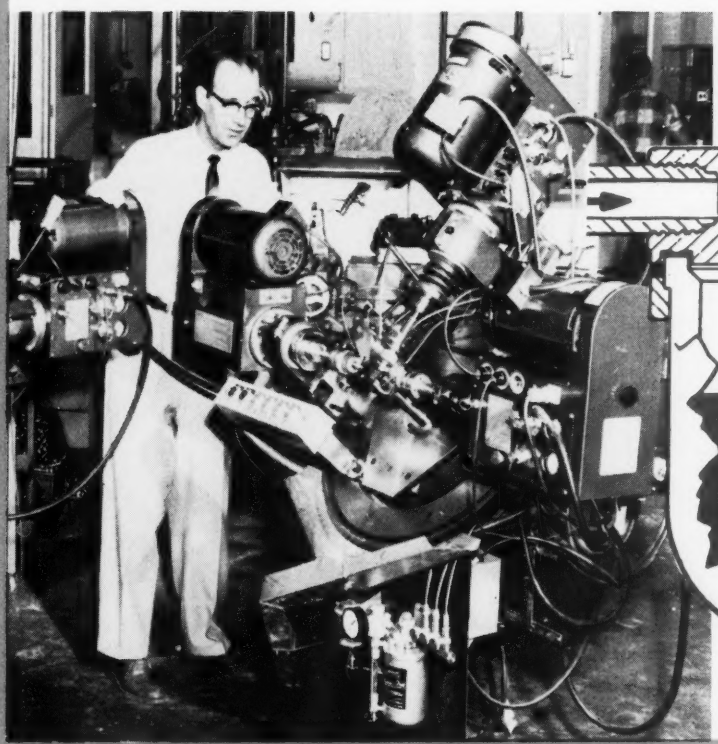
LUBRICATION ENGINEERING

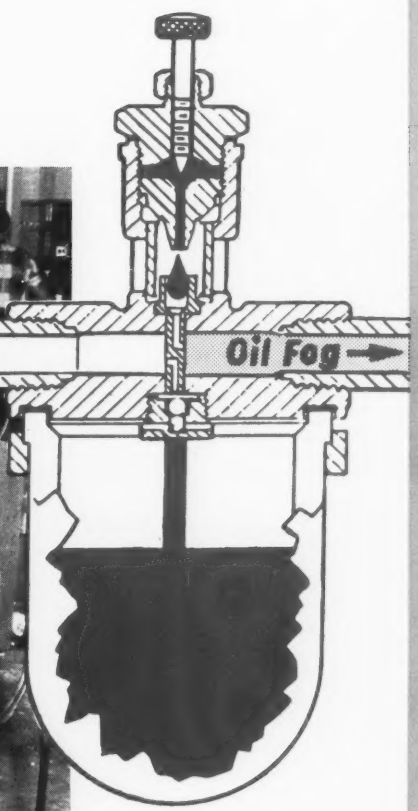
DESIGN RESEARCH APPLICATION EDUCATION MAINTENANCE

OIL-FOG LUBRICATION

—Past, Present, Future

SEE PAGE 372





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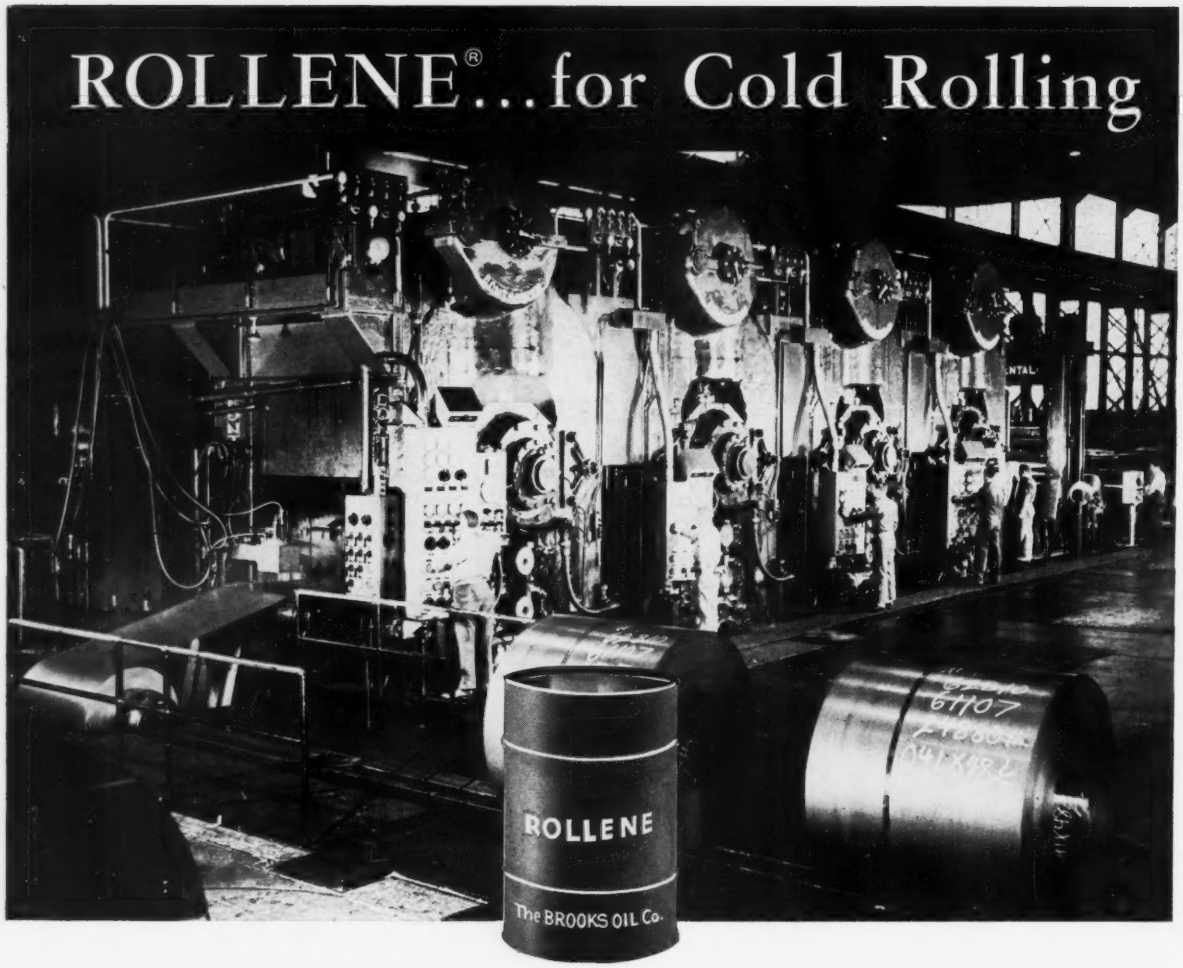

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August, 1961

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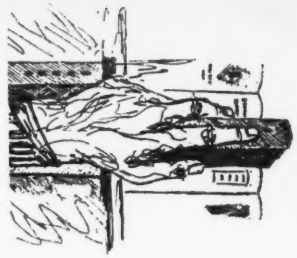

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Volume 17, No. 8
August, 1961

Lubrication Engineering

DESIGN RESEARCH APPLICATION EDUCATION MAINTENANCE

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A. F. Brewer, Consulting Editor
Flo Shoemaker, Pubns. Manager
Donald B. Sanberg, Executive Secty., ASLE

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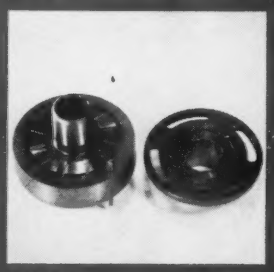
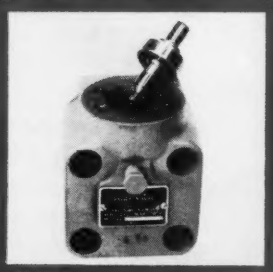
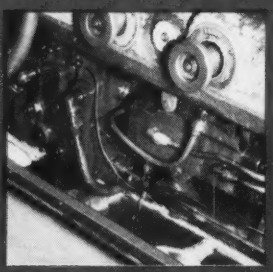


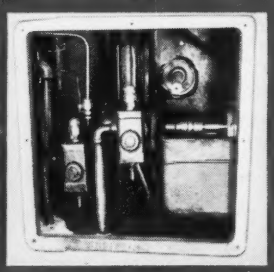
PUMPS Wear is kept to a minimum. Pump parts remain free of choking varnish deposits for efficient operation.



VALVES Carefully selected additives combine with high-quality oils to prevent wear, rusting and deposit formation.



ORIFICES Freedom from deposits in vanes, orifices and drains helps keep equipment at work, reduces maintenance costs.



SUMPS Rapid dissipation of foam in oil sumps avoids pump cavitation and annoying shutdowns, reducing costly down time.

The type of fluid power transmission medium used in a hydraulic system is largely responsible for its economical and effective operation. Realizing the importance of oil stability to successful service, manufacturers of hydraulic equipment long have recommended oils having the same properties found in turbine lubricants which must operate continuously for long periods of time.

Atlantic Hytherm Oils are basically turbine quality products. They are produced from solvent treated paraffin base stocks which have a high viscosity index. In addition, they are fortified with additives to resist oxidation and foaming as well as to protect machine parts against rust.

The most outstanding feature of Hytherm oils is their anti-wear characteristic . . . a direct result of this unique additive combination. Compared in performance under identical conditions, with high-quality straight mineral oils of comparable viscosity, Atlantic Hytherm Oils actually cut wear-rate of vane type pump parts 100 times. Savings in maintenance costs and equipment down time far exceed the moderate increase in cost of the Hytherm oils above ordinary mineral oils.

And Atlantic Hytherm Oils also provide excellent versatility. In fact, they've been used successfully in a variety of "hot-oil" heat exchange systems with a minimum of undesirable deposits. They are highly recommended for lubricating compressor cylinders, rotary compressors, enclosed gear and chain drives, dryer roll circulating systems, machine tool drives, small steam turbines and other applications where over-all stability is highly necessary.

Your Atlantic Sales Engineer will welcome the opportunity to discuss the application of these oils to your specific requirements. In cases where detailed analysis is required, the facilities of the Product Development & Technical Services Division are at your disposal, entirely without obligation. Simply call or write to The Atlantic Refining Company, Pennypacker 5-2345, 260 S. Broad Street, Philadelphia 1, Pa.

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CHOOSE FROM OUR FULL RANGE OF HIGH-QUALITY OILS TO MEET YOUR LUBRICATION NEEDS

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NEW PRODUCTS

The Society will not be responsible for the accuracy of statements made in this column. Any reference to proprietary products does not imply an endorsement of such products by the Society.

AUTOMATIC OILERS ANNOUNCED

Automatic, controlled lubrication of bearings on all Sturtevant dry processing equipment now is possible with a solenoid-actuated lubricator which drip-feeds oil to bearings whenever machinery is in operation, yet cuts out automatically when machinery stops.

The lubricator releases oil by gravity from a transparent reservoir through single or multiple sight feed valves, providing individual flow to each bearing. The visibility of the oil reservoir aids in preventing the chance of "running out" of oil and damaging the bearings.

The automatic oiler is available from Sturtevant Mill Co., Boston only for Sturtevant grinding, blending, mixing, and classifying equipment.

Circle No. 1 on Reader Service Card

EXTREME-ENVIRONMENT DRY-FILM BONDED LUBRICANT MARKETED

Molykote X-15, an inorganic-bonded, dry film lubricant with a useful temperature range of from −300 to +1200 F is now being produced by The Alpha-Molykote Corporation, Stamford, Conn.

In addition to its wide temperature range, Molykote X-15 is insensitive to liquid oxygen; has proven to be unaffected by up to 5×10^6 roentgen gamma radiation; is said to retain its lubricating properties under vacuums up to 10^{-9}mm of Hg; and is easy to apply in either shop or field.

Molykote X-15 can be applied by brushing or spraying on clean surfaces. It air dries to a tough, resilient coating in one hour at room temperature.

Circle No. 2 on Reader Service Card

NEW MOLD RELEASE-LUBRICANT OFFERED

A dry mold release and lubricant that can be sprayed on parts and materials as an easily-identified color coating has been developed for a wide range of industrial uses in such areas as plastic fabricating, rubber, and metal fabricating. The product is marketed as S-122-C mold release-lubricant by the Miller-Stephenson Chemical Company, Inc., South Norwalk, Conn.

The color-base material, which is now available in developmental quantities, permits users to distinguish between coated and noncoated areas and helps improve application efficiency. Packaged in easy-to-apply aerosol containers, the S-122 agent is already in full production as a transparent medium.

Circle No. 3 on Reader Service Card

NEW INDUSTRIAL CENTRALIZED LUBRICATION SYSTEM ANNOUNCED

The availability of Alemite "Meter-Pak" centralized lubrication systems for gas and process compressors, large diesel engines, and other heavy industrial equipment including turbines and pumps, has been announced by Stewart-Warner Corporation, Chicago.

Declared to be a versatile and flexible system, designed for the critical job of protecting multiple bearing points on either attended or remote equipment, "Meter-Pak" offers several outstanding and exclusive features, the Alemite Division of Stewart-Warner states. Some of the system's features are: valves are individually adjustable, for delivery of from .003 to .015 cubic inches of oil each time the system is cycled; delivery is plus or minus five percent, over all ranges of volume and pressure settings, regardless of oil viscosity, oil type, or temperature; Meter-Pak spans 100-7,000 psi pressures. A safe remote control is provided.

Also available is a visual lubricant cycle counter system for use on installations not requiring remote signalling or control.

A full line of powered pumps, capable of serving from ten to 1000 lubrication points and with pressure ratios and ranges and reservoir capacities to meet every requirement, is available for use with Meter-Pak.

Circle No. 4 on Reader Service Card

ALL PURPOSE MACHINING COMPOUND DEVELOPED

A new petrochemical derivative, compound B/G No. 576 is said to possess high film strength with good wetting ability, and corrosion prevention characteristics, which make it suitable for a variety of operations and metals. The manufacturer claims the product to be 100% soluble in water, non-toxic, and practically immune to bacterial action.

B/G No. 576, manufactured by Baker/Gubbins Co., Detroit, Michigan, is adaptable to large central systems due to its property of rejecting "tramp" oils, and its low "drag out" on parts being machined.

Circle No. 5 on Reader Service Card

NEW SAFE LEVEL SIGHT FEED FOR LUBRICATORS

Lubricator Division of McCord Corporation, Detroit, Michigan, announces the availability of the new McCord No. A 32156 Safe Level Sight Feed for use on Model "55" Force Feed Lubricators. This new device acts as a safety feature giving warning that entrained air can stop oil feeding of the lubricator.

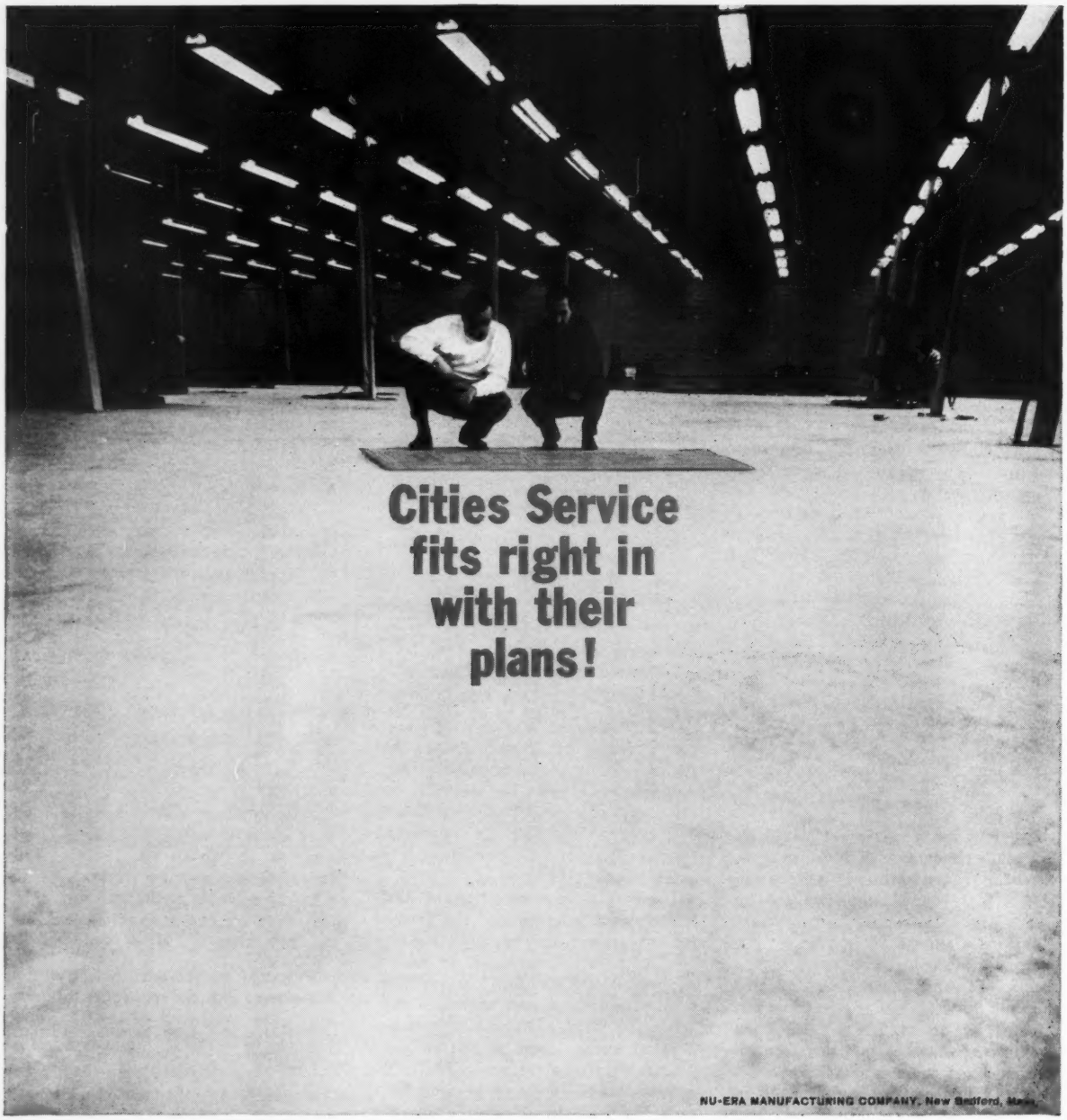
Features of the new No. A 32156 Safe Level Sight Feed are as follows:

1. Quick and easy priming without necessity of disconnecting the oil line.
2. Can be installed on any McCord Model "55" lubricator feed.
3. Unnecessary to disturb the sight feed glass when servicing the lubricator feed.
4. Improved sealing by metal to metal contact.

In the Model "55" the new No. A 32156 Safe Level Sight Feed acts as an air filter chamber as long as the oil level can be seen in the glass. When the oil level decreases in the Safe Level Sight Glass, it is a warning that there is excessive aeration in the oil.

Circle No. 6 on Reader Service Card

(*Continued on page* 363)



There's a bright future ahead for Nu-Era, manufacturer of replacement gears. The firm recently built this huge plant to handle increased orders... and Cities Service definitely fits in with their plans. Says General Manager Bill Rebone, "At first, all cutting oil brands seemed to be the same. However, we soon realized that Cities Service oils were giving us superior performance in every respect. Most of our gears are made of #5135 steel, a real tough customer to work with. Yet, we find we're getting long tool life, extra clean cuts with Cities Service Chillo 30 Cutting Oil." Nu-Era now relies, exclusively, on Cities Service for their metal machining fluids. Find out how Cities Service can fit in with your plans. Simply contact your nearest Cities Service office or write: Cities Service Oil Company, 60 Wall Street, N.Y. 5, N.Y.

CITIES SERVICE

Out Front in Quality... Out Front in Service, too!

NEW PRODUCTS

(*Continued from page* 361)

INDUSTRIAL RUST PREVENTIVE AVAILABLE

Commercial availability of a new, light oily liquid which is claimed to stop metal from rusting has been announced by Ronco Laboratories, Pittsburgh, Pennsylvania. Trade-marked Ferro-Gard, the material is said to stop rusting and corrosion before they begin. It is applied simply by brush, spray, dip or fogging.

The liquid product is said to meet Army Ordnance Specifications MIL-L-46002 (Ord.) 16 for a volatile corrosion inhibitor.

Circle No. 7 on Reader Service Card

QUENCHING OIL FORMULA DEVELOPED

Aldridge Industrial Oils, Inc., Cleveland, Ohio announces the development of Deacon K-65 with Quenzine Quick Quench Oil, a quenching oil for use on the difficult to harden steels when the best metallurgical properties are required.

Deacon K-65 with Quenzine quick quench oil has been developed to meet a need of properly hardening borderline steels and increasing core hardness of low carbon steels which have been carburized.

Many carbon steels, lean in alloys, which formerly had to be hardened in water or brine and resulted in excessive cracking and distortion can now be oil quenched in DEACON K-65 with Quenzine quick quench oil.

Circle No. 8 on Reader Service Card

"RULON" SPRAY OFFERED

"RULON" Spray—an easy-to-apply reinforced fluorocarbon slip and anti-stick agent—is offered in an aerosol spray can by the manufacturer, Dixon Corporation of Bristol, R.I.

"RULON" Spray quickly and easily provides a low-friction, slick surface for wood, metal, leather, plastics, etc. . . . leaves a dry, non-gummy film that will not collect dust. It has a coefficient of friction as low as .07 and eliminates "stick-slip" at low speeds. It is useful as a lubricant for belts, gaskets, packings, gears, bearings, cord, cable, machine parts, conveyors, wood and metal working, metal cutting; and as an anti-stick agent for blenders, tanks, chutes, conveyors.

Circle No. 9 on Reader Service Card

NEW LUBRICATING OIL BLENDER ANNOUNCED

New continuous-flow equipment for precise blending of multiple-ingredient lubricating oils is announced by Girdler Process Equipment Division of Chemetron Corporation.

The manufacturer reports viscosities of fininshed products are held to within plus-or-minus 0.2 seconds Saybolt Universal by the new system, which accurately proportions the component base oils and costly additives at rates up to several hundred gallons per minute.

The system is claimed to offer advantages of lower initial investment, reduced maintenance and operating costs and more precise proportioning of complex modern lubricating oil formulas than previously available continuous-process methods.

Production can be switched from one grade oil to another in a matter of minutes, reducing the need to carry large inventories of a number of finished grades. It is said that in normal operation carry-over of oil from a previous grade is so slight that the first container filled with the new grade will be within specifications.

Suggested ideal location for the continuous-process system, is at bulk terminal stations where feed can be taken directly from adjacent storage tanks and drums by suction.

Circle No. 10 on Reader Service Card

CORROSION RESISTANT DRY SOLID FILM LUBRICANT ANNOUNCED

ELECTROLUBE, a new air dry solid film lubricant priced and produced for commercial applications, has been developed and field tested by Electrofilm, Inc., of North Hollywood, California. This one-coat, air-dry lubricant can be applied by spraying, dipping, or spray-tumble. The coating combines corrosion resistance and lubrication in one step. Parts coated with Electrolube are said to have withstood 100 hours salt spray tests with no visible traces of corrosion. Priced for conveyor and production line applications, Electrolube is available in 50 gallon drums or 5 gallon cans. In production tests, 339 pounds of die cast aluminum parts at 45 pieces per pound will use only one gallon of Electrolube concentrate. This new coating is only .0002" to .0005" thick with a coefficient of friction as low as .025 under high loads.

Circle No. 11 on Reader Service Card

NEW LINE OF JOURNAL BUSHINGS OFFERED

A new line of self-lubricating, plain, journal bushings, said to be capable of dynamic loads of 25,000 psi and static yield loads to 50,000 psi at low rotational speed without damage, is now being offered by Southwest Products Co., Monrovia, Calif.

Stainless steel housings are employed and the bushings have a plastic insert made of "Dyflon." Bore sizes are from ¼" to 3".

It is reported that at highest dynamic loading, no galling, fretting nor brinelling will occur.

Circle No. 12 on Reader Service Card

B-F MOLYLUBRICANT PACKED IN HANDY SPRAY CANS

B-F Molylubricant, general purpose lubricant, is now being packaged for industrial use in a convenient spray can by the Chemical Products Division of Bridgeport Fabrics, Inc., Bridgeport, Conn.

B-F Molylubricant Spray is a compounded solid lubricant, molybdenum disulphide, dispersed as microfine particles. It is non-inflammable, non-corrosive, and non-toxic. It dries quickly, providing a tenacious long lasting film. It is a non-conductor of electricity and is thermably stable under temperatures from minus 300 degrees to plus 700 degrees Fahrenheit. It is unaffected by salt water and most acids and alkalis. B-F Molylubricant is said to have a low coefficient of friction.

Circle No. 13 on Reader Service Card

NEW INDUSTRIAL FILTRATION SYSTEM DEVELOPED

Poro-Pac filters have been developed by the Pacific Sintered Metals Company, Los Angeles, California to provide industry with complete micronic filtration systems removing contaminants to five microns from all liquids and gasses. The Poro-Pac features corrosion resistant brass cases; Porous metal Sintered Bronze, ductile shock proof elements, that are easily cleaned and require no replacement; and operating temperatures of −400 F. to +900 F. All cases are rated at 250 psi and are completely sealed with "O" rings. All sizes are stocked for immediate shipment.

Circle No. 14 on Reader Service Card

■*Fourth in a series of articles designed to promote broader understanding of colloidal dispersions.*

there's more to this than meets the eye

Take a good look sometime at a premium quality colloidal dispersion of graphite or molybdenum disulfide in oil. You'll need about a 1000 power microscope with an oil immersion lens. A brief note to the address below will quickly put inspection samples of colloidal graphite ('Oildag'®) and colloidal MoS_2 ('dag'® 200) in your hands. Since these are concentrates, they should be diluted with light oil about fifty times for most effective viewing.

What you will see—even at this low solids content—are thousands of finely divided, flake-like particles smaller than a micron in even their largest dimension. Interestingly, they will exhibit the random motion of Brownian movement as they are bombarded by the molecules of the diluent oil. You will note their presence as singular, discreet, particles acting independently of each other in the suspension.

But what of the many characteristics of these dispersions that are not likely to be seen in this way? Though it may not be too well-known, there is a great deal more to the manufacture of useful colloidal products than the simple mixing of finely divided particles with suitable liquids. This, really, is only a beginning.

At Acheson Colloids, product planning recognizes *first* the requirements of the end use for which the dispersion is intended. Thus, those important properties whose presence a microscope can only suggest are engineered into the product at its inception and there maintained by attentive quality control. Real and measurable benefits are the result to the user.

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A division of Acheson Industries, Inc. Also Acheson Industries (Europe) Ltd. and affiliates, London, England. Sales offices in principal cities.

PRODUCT LITERATURE

The Society will not be responsible for the accuracy of statements made in this column. Any reference to proprietary products does not imply an endorsement of such products by the Society.

FREE LITERATURE ON PREMIUM LUBRICANTS

A new comprehensive 20-page plastic-bound booklet featuring premium lubricants is being offered by Hercules Packing Corp. of Alden, New York.

This booklet offers a collection of information featuring the basic concept of Molybdenum Disulfide Additives employed to increase temperature capabilities of lubricants. It contains two pages of charts, diagraming the reduction of frictional resistance between moving parts.

Also included are sections featuring functional operation, physical properties and practical application.

Circle No. 15 on Reader Service Card

CENTRALIZED LUBRICATION EQUIPMENT CATALOG PUBLISHED

Catalog 82, illustrating and describing its line of centralized lubrication equipment, has just been published by Lincoln Engineering Company, St. Louis, Mo.

Featured in the 32-page catalog is Lincoln's complete line of lubricant application equipment with descriptions of fully automatic, semi-automatic and manual methods of operation.

High and low pressure lubricant injectors, timing and alarm controls and filler pumps are described along with several pages of installation accessories such as tees, hose, flexible feed lines, coupling studs.

Circle No. 16 on Reader Service Card

PLASTIC SLEEVE BEARINGS BROCHURE PUBLISHED

A six page brochure, offering criteria for designing plastic sleeve bearings, for applications in adverse abrasive or corrosive conditions or in non-lubricated or silent bearings, has been published by Cadillac Plastic and Chemical Co., Detroit, Michigan.

Criteria discussed, include material selection, limiting loads and speeds, fit and clearance, effects of temperature, cold flow, and recommended configurations. Standard clearances are tabulated in charts, while graph provides information on the effect of long term loading.

Table of properties compares plastics most suitable for sleeve bearings —nylon 6, nylon 6/6, Delrin, Teflon— from the standpoint of bearing design, comparison covers coefficients of friction, fatigue endurance limits, temperature limits, PV values and the effects of moisture on weight and dimension.

Booklet is illustrated with photographs of applications, sketches of recommended configurations, charts and tables of properties.

Circle No. 17 on Reader Service Card

TECHNICAL BOOKLET ON MORPHOLINE ANNOUNCED

Morpholine is the subject of a technical brochure which has been made available by Jefferson Chemical Company, Houston, Texas. This chemical is used as an intermediate for rubber chemicals, a corrosion inhibitor in steam boiler systems and as a separating agent for volatile amines. Various derivatives are used in the manufacture of waxes and polishes, bactericides, lubricating oils, and as textile lubricants and sizing emulsifiers.

The brochure includes up-to-date data on sales specifications, analytical procedures, handling and storage, physical and chemical properties. It includes a toxicity statement and an extensive bibliography.

Circle No. 18 on Reader Service Card

BROCHURE ON LEATHER PACKINGS OFFERED

Leather Packings for Hydraulic Pneumatic Service is the title of a new brochure just published by Garlock Inc., Palmyra, N.Y.

Garlock's leather packings are available in a variety of sizes and shapes including "U", cup, Vee, flange packings, gaskets and washers.

The new catalog offers complete tannage and impregnation information (including the new Moly S_2) as well as detailed design data that includes standard design dimensions, installation procedures, allowable clearances and ordering information for each type of packing.

Circle No. 19 on Reader Service Card

ENGINEERING GUIDE AVAILABLE ON CARBON-GRAPHITE MATERIALS

An 8-page illustrated engineering guide on carbon-graphite materials for mechanical applications is available from National Carbon Company, Division of Union Carbide Corporation, New York City.

Grade recommendations are presented for seals and sliding surfaces for a wide range of liquids and gases at operating temperatures up to 500 F., above 500 F., and in the cryogenic range. Detailed discussions are included on carbon-graphite materials' high elastic modulus, total impermeability, maintained flatness, resistance to chemical attack, thermal conductivity, and low friction and wear.

The bulletin tabulates the 18 grades of "National" carbon, graphite, and carbon-graphite available for mechanical uses such as bearings, bushings, and seals, and lists properties for each grade, including: apparent density; hardness; compressive, tensile, and flexural strength; elastic modulus; thermal conductivity; coefficient of thermal expansion; and maximum recommended temperature.

Circle No. 20 on Reader Service Card

BROCHURE ON HIGH TEMPERATURE LUBRICANTS AVAILABLE

General Magnaplate Corporation, Belleville, N.J., announces the availability of a new brochure describing its latest high temperature lubricant, Hi-T-Lube.

Hi-T-Lube, a new multi-layer solid film lubricant which is said to provide a lower coefficient of friction as pressure increases . . . and an almost constant coefficient of friction at temperatures ranging from 100 F to 1500 F.

The brochure presents charts summarizing procedures and results of the manufacturers' tests in which Hi-T-Lube became an integral part of bearing surface by pressure or heat —and when Hi-T-Lube was unremovable, reducing wear and increasing operating life of all metals as shown in the charts.

Circle No. 21 on Reader Service Card

Many of the top engineers and scientists concerned with lubrication problems will attend the

8th Annual Lubrication Conference

MORRISON HOTEL • CHICAGO

October 17, 18, 19, 1961

Sponsored by the American Society of Lubrication Engineers and the Lubrication Division of the American Society of Mechanical Engineers in cooperation with the Chicago Sections of both Societies.

Timely topics to be discussed at Chicago will provide a status report on advanced problems and solutions—to *help you!* Hear discussions on:

LUBRICATION IN VACUUM FOR OUTER SPACE—Bearing experiments, lubricant evaporation, wear and friction studies—open discussion!

GAS BEARINGS—Analysis, designs, applications and performance of externally pressurized and self-acting configurations.

ROLLING CONTACT BEARINGS—Studies at extreme temperatures and speeds; materials, methods of lubrication, endurance life. Instrument bearings.

PROPERTIES OF LUBRICANTS—Greases, gases, liquids, solids. Thermal and atmospheric influences.

CHEMISTRY OF SURFACE FILMS—Interaction of lubricated metal, lubricant and environment and their contribution to lubrication processes. Special research techniques.

FRICTION AND WEAR—Studies to clarify lubrication processes and properties of materials in sliding contact.

GEARS—LIQUID FILM BEARINGS—METAL PROCESSING—NUCLEAR SYSTEMS.

Twenty ASLE Papers to be presented

at the 1961 Lubrication Conference

Twenty important papers are scheduled to be presented by ASLE authors at the 1961 ASLE-ASME Lubrication Conference. This conference will be held at the Morrison Hotel in Chicago, October 17, 18, 19, 1961. Sponsored jointly by the American Society of Lubrication Engineers and the Lubrication Division of the American Society of Mechanical Engineers, this year's meeting is expected to be very well attended by members of both societies. Listed below are the titles of the papers to be presented by ASLE authors.

Preprints of the papers below will be available at the Conference for those attending. They will also be available at the ASLE National Office for mail-orders after October 15, 1961.

Bearing and Lubricant Requirements for Some Aero-Space Projects: Discussion and Preliminary Investigation, by R. H. Larson, A. G. Piken, Bendix Research Labs., Southfield, Mich. ..... **Paper No. 61LC-1**

Friction, Wear, and Evaporation Rates of Various Materials in Vacuum to 10^{-7} mm Hg, by D. H. Buckley, M. Swikert, R. L. Johnson, NASA, Lewis Research Center, Cleveland, Ohio ..... **Paper No. 61LC-2**

Friction and Wear Characteristics of Cermets at High Temperature and High Vacuum, by R. D. Brown, R. A. Burton, P. M. Ku, Southwest Research Inst., San Antonio, Texas **Paper No. 61LC-3**

Friction and Surface Deformation During Sliding on a Single Crystal of Copper, by J. M. Bailey, Dept. of Physics, Beloit College, Beloit, Wisc., A. T. Gwathmey, Dept. of Chemistry, University of Virginia, Charlottesville, Va. **Paper No. 61LC-4**

Chemical Changes in Steel Surfaces During Extreme Pressure Lubrication, by D. Godfrey, California Research Corp., Richmond, Calif. ..... **Paper No. 61LC-5**

Extreme Pressure Lubrication and Wear. The Chemical Reactivity and the Extreme Pressure Action of two Aliphatic Disulfiides, by A. Dorinson, V. E. Broman, Sinclair Research Labs., Inc., Harvey, Ill. ..... **Paper No. 61LC-6**

Polymer Formation on Sliding Metals in Air Saturated with Organic Vapors, by W. E. Campbell, Consultant, Cleveland Heights, Ohio, R. E. Lee, Jr., General Electric Co., Schenectady, N. Y. ..... **Paper No. 61LC-7**

Effect of Lubricant Viscosity on Metallic Contact and Friction in a Sliding System, by M. J. Furey, J. K. Appeldoorn, Esso Research and Engineering Co., Linden, N. J. **Paper No. 61LC-8**

Heat of Preferential Adsorption on Surfactants on Porous Solids and its Relation to Wear of Sliding Steel Surfaces, A. J. Groszek, British Petroleum Co., Lt., Sunbury-On-Thames, Middlesex, England ..... **Paper No. 61LC-9**

Preparation, Properties, and Some Applications of Super-Refined Mineral Oils, by E. E. Klaus, E. J. Tewksbury, M. R. Fenske, Petroleum Refining Lab., Pennsylvania State University, University Park, Penna. ..... **Paper No. 61LC-10**

Factors Affecting Nuclear Power Plant Lubricants, by D. B. Cox, E. A. Obberright, R. J. Green, Socony Mobil Oil Co., Research Dept., Paulsboro, N. J. ..... **Paper No. 61LC-11**

Viscous Lubrication in Wire Drawing, by F. Osterle, J. R. Dixon, Carnegie Inst. of Technology, Pittsburgh, Penna. **Paper No. 61LC-12**

Effects of Base Oil Viscosity and Type of Bearing Ball Fatigue, by F. G. Rounds, General Motor Corp., Warren, Mich. ..... **Paper No. 61LC-13**

The Effect of Contact Angle on Rolling Contact Fatigue and Bearing Load Capacity, by E. V. Zaretsky, W. J. Anderson, R. J. Parker, NASA, Lewis Research Center, Cleveland, Ohio ..... **Paper No. 61LC-14**

Weibull Distribution of Rolling Contact Fatigue Life and Deviations Therefrom, by T. Tallian, SKF Industries, Inc., Philadelphia, Penna. ..... **Paper No. 61LC-15**

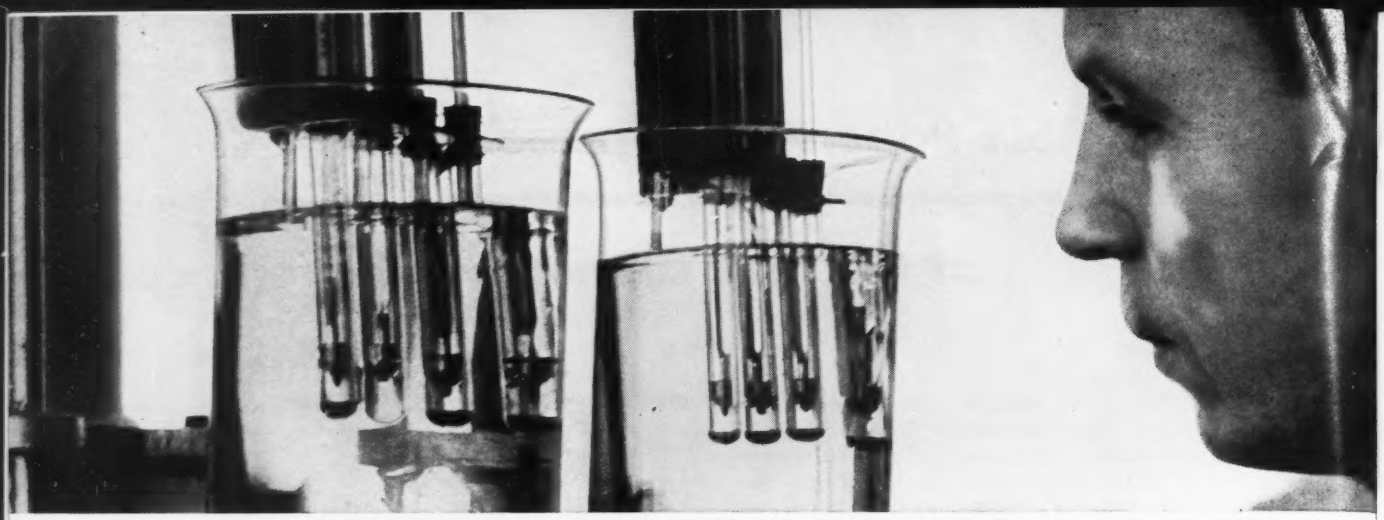
Evaluation of Ball Bearing Performance in Liquid Hydrogen at DN Values to 1.6 Million, by H. W. Scibbe, W. J. Anderson, NASA, Lewis Research Center, Cleveland, Ohio. **Paper No. 61LC-16**

Lubrication of Rolling Surfaces by a Ree-Erying Fluid, by J. C. Bell, Battelle Memorial Inst., Columbus, Ohio **Paper No. 61LC-17**

Design of Externally Pressurized Gas Thrust Bearings, by D. C. Allais, IBM Research Lab., San Jose, Calif. **Paper No. 61LC-18**

Pressure and Flow Studies of an Experimental Pressurized Gas Lubricated Bearing, by C. B. Speen, I.T.T. Federal Labs, San Fernando, Calif. ..... **Paper No. 61LC-19**

Synthesis of Externally Pressurized Gas Bearings, by W. A. Gross, I. Tang, IBM Research Labs., San Jose, Calif. **Paper No. 61LC-20**



Dropping point test shows how greases react to heat. Beaker fluid has been heated to 390°F. All greases tested except Darina (second tube from let) have passed from solid to liquid state.

BULLETIN:

Shell reveals the remarkable new component in Darina Grease that helps it save up to 35% on grease and labor costs

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Darina lubricates effectively at temperatures 100° hotter than most conventional soap base greases can withstand.

Read how this new multi-purpose industrial grease can help solve your lubricating problems and even save you up to 35% on grease and labor costs.

THERE IS no soap in Darina Grease. No soap to melt away—wash away—or dissolve away.

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SOCIETY NEWS

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JUNE, 1961

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BILLING PROCEDURE CHANGE

The ASLE National Office is now requesting payment in advance on all small orders ($3.00 or under) and on all overseas orders for publications and other services. A recent study of billing and collection procedures pointed out that about 60% of the invoices written were for very small amounts, and that the cost of writing the invoice exceeded the amount collected in many cases.

Better than 80% of the total amount on outstanding invoices older than 90 days were found to be billings to overseas individuals and concerns. It is hoped that this will not cause any inconvenience to customers and that the need for this change will be understood. Exceptions to the rule on overseas orders are being made for those concerns and individuals that have established their credit with the ASLE National Office.

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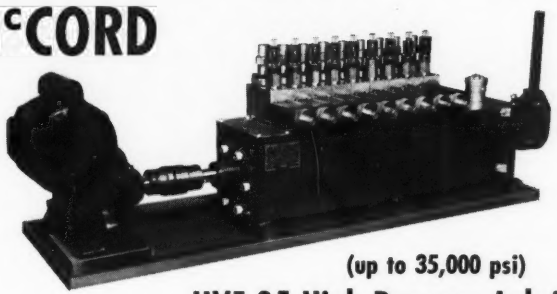

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HVF 35 is designed to feed oil . . . a fraction of a drop or 12 drops per minute with extreme accuracy. It's precision-built to provide positive, dependable oil delivery with every impulse of the plunger. And versatile! . . . any combination of drive, location or type, number of feed or compartment arrangements are yours for the asking.

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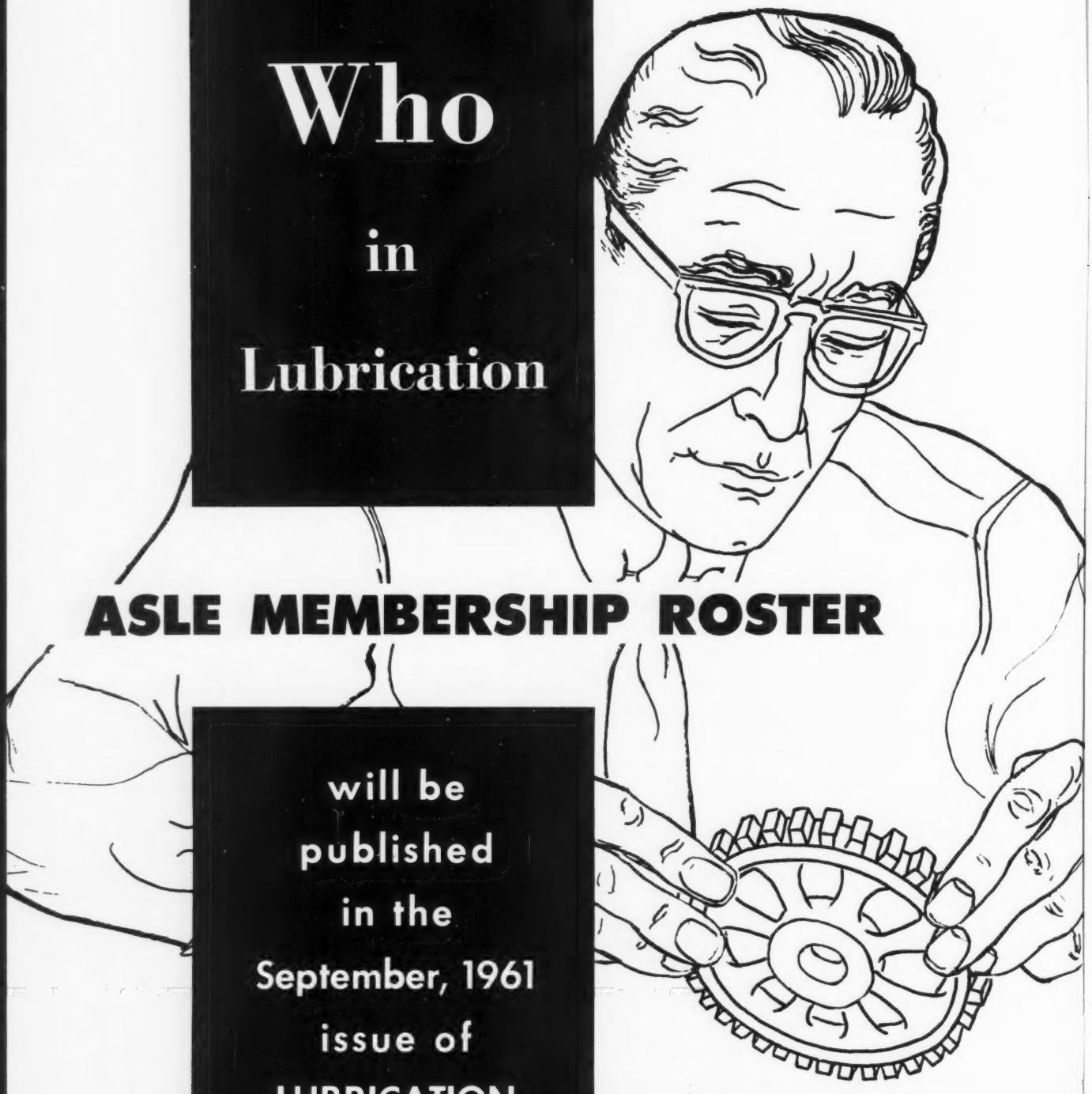
Who's Who in Lubrication



ASLE MEMBERSHIP ROSTER

will be published in the September, 1961 issue of LUBRICATION ENGINEERING

Vol. 17, No. 8

Lubrication Engineering

industrial members

Thirty-two companies are Industrial Members of ASLE. They believe that this organization is well worth their support—and demonstrate it by the active participation of their people.

Even though I may be somewhat biased, I believe these companies have shown a lot of foresight in taking this action. It marks them as leaders in recognizing the necessity of taking lubrication out of the class of an "art" and making it a science discipline with its attending body of knowledge.

By their memberships they publicly affirm their endorsement of the program and objectives of ASLE—the one international organization devoted exclusively to lubrication. It seems appropriate to call your attention to these companies, listed on the inside back cover.

Is your company on this list? It probably should be—ASLE needs its support, and it needs ASLE. A minute of your time to let the National Office know who to contact in your company is all that is required to start the ball rolling.

Dean M. Cleaveland
President, ASLE

Some of the pertinent history pertaining to the development of oil-fog lubrication devices and techniques are discussed and two fundamental design concepts concerning such devices are defined. The differences between Oil-Fog lubricators employed for air actuated equipment and those used in centralized-lubrication-systems for industrial machinery are discussed. System-design procedures for application of oil-fog lubricators are presented and consideration is given to the future of oil-fog lubrication.

OIL-FOG LUBRICATION

—Past, Present and Future

by D. G. Faust,
Vice-President of Marketing,
C. A. Norgren Company
Englewood, Colorado

This paper will discuss progress which has been made in the field of oil-fog lubrication and attempt to clarify some of the confusion, misunderstanding—or lack of understanding, which undoubtedly detracts from the most successful utilization of oil-fog lubrication. This is not a highly technical paper, but is intended to assist industry in understanding and applying oil-fog lubrication advantageously.

THE PAST

The development of the art of oil-fog lubrication started in the United States about 1926 with the invention of the oil-fog lubricator by Carl Norgren. The original device was developed to provide an improved means of lubricating air-operated tools. This lubricator was slow in gaining acceptance, not because the lubricator failed to fulfill its purpose, but because most portable tools were connected to the air supply by means of flexible hose, and the hose of that day had a natural rubber core which swelled and deteriorated rapidly in the presence of oil. The development of oil-resistant synthetic rubbers substantially changed this picture, making it practical to convey lubricating oil fog through flexible hose. Then the full advantages of oil-fog lubrication were realized for the first time. The compressed air power supply could now be used to convey the lubricant, thus assuring continuous lubrication of all operating components within the tool.

In the latter 1930's, the development of relatively high-speed precision grinders indicated a need for improved bearing lubrication techniques. The possibilities of oil-fog lubrication were investigated and found to be advantageous. In this instance, no compressed air was required to operate the grinder. Air was used only to convey to the bearings the lubricant in the form of a fog. This was a departure from the original concept of lubricating air-operated tools and equipment and was undoubtedly the beginning of what is now recognized as the centralized aerosol lubrication system.

The acceptance and utilization of oil-fog lubrication principles for the lubrication of air tools, cylinders, valves, and other air-actuated devices, progressed quite rapidly; but, for many years, it was felt that the lubrication of bearings, gears, and other machine-tool components by the aerosol technique was limited to relatively small, high-speed precision devices. This concept was shattered in 1949 by the development of an oil-fog lubricator which produced a very finely divided oil fog having a much greater uniformity of particle size than any of the previously available devices. The individual oil-fog particle produced by this lubricator was approximately two microns in diameter. This type of fog could be transmitted through complex distribution systems and proportionately deposited on bearing surfaces of varying sizes, thus making possible complex and extensive centralized lubrication systems for all types of industrial machinery utilizing the oil-fog or lubricating aerosol technique.

Presented at the 16th Annual Meeting in Philadelphia, Pa., April, 1961.

It is quite fundamental that the only difference between lubricating the small bearing or bearing surface as compared to a large one is the amount of lubricant required and that regardless of the size, the basic lubricant requirement is the thin film of oil needed to separate the two bearing surfaces. Any additional lubricant is excessive, adding to lubricant costs and, in some instances, actually detrimental to the operation of the equipment. The aerosol-lubrication principle afforded the possibility of approaching this optimum lubrication condition. The aerosol lubricator output can be accurately adjusted to provide a continuous flow of fresh, clean lubricating oil at a rate which satisfactorily maintains the desired oil film without any undue excess.

At this point, aerosol lubricators having high oil-output capabilities were needed so that a single device could supply adequate lubrication to large, complex machines. Such lubricators have been developed. Today, industry has available to it a large variety of sizes and types of aerosol-lubricating devices—there is an aerosol lubricator ideally suited for practically every lubrication requirement. This complexity of equipment is responsible for some of the confusion referred to earlier, and it will be the purpose of this paper, at least in part, to resolve this situation.

PRESENT

There are today many manufacturers of aerosol-lubricating devices. Naturally, the design, configuration, and performance claims vary considerably. It is therefore understandable why the purchaser or ultimate user of this type of equipment is confused.

Before proceeding further, it would be well to define "aerosol lubricator": The dictionary defines, "aerosol" as "A system consisting of colloidal particles dispersed in a gas, a smoke, or fog." Specifically, an aerosol lubricator is a device which creates a dispersion of lubricating oil within a compressed-air system.

To assist in the proper selection of aerosol lubricating devices, it must be understood that there are *two distinct application categories* and *two fundamental operating principles* embodied in aerosol lubricating devices.

Application Categories

The most predominant use of aerosol lubricators is for the lubrication of air-operated devices such as tools, cylinders, valves, etc. These devices use the compressed air as a power source; and when an aerosol lubricator is connected into the system, the power source, or compressed air, is also a conveyor of lubricant. Aerosol lubricators used for this purpose must be capable of handling compressed air at flow rates compatible with the connected equipment requirements and without introducting a significant pressure drop which will detract from the equipment efficiency and must be capable of accurately metering small quantities of lubricant into a high-velocity air steam. This lubricant is then conveyed to the connected equipment as a *low concentration* of oil fog in air.

The second category is that which is used for the lubrication of machine components such as bearings, gears, chains, etc., where the air furnishes no motive power but is merely a conveyor of lubricant. For this purpose, it is desirable to keep air consumption to a minimum; therefore, low air-flow rates at low pressure are used, and the aerosol lubricator must be capable of producing a *high concentration* of oil fog in air.

Although the outward appearance of the devices offered for these two purposes may be similar, their internal construction and performance characteristics differ considerably, and *they cannot be used interchangeably.*

Operating Principles

There are two fundamental operating principles embodied in aerosol lubricating devices. The design, configuration and construction may vary considerably; however, the fundamentals apply.

Fig. 1 illustrates the fundamental design concept of the original oil-fog lubricator. The oil contained in the reservoir is induced to flow upward through the siphon tube and into the venturi section as the result of the pressure drop created by the air passing through the venturi. All of the oil which enters the venturi section goes into the compressed air line. The oil is broken up into a fog having a great variety of particle sizes and is conveyed to the connected equipment partially as a fog and partially as liquid oil.

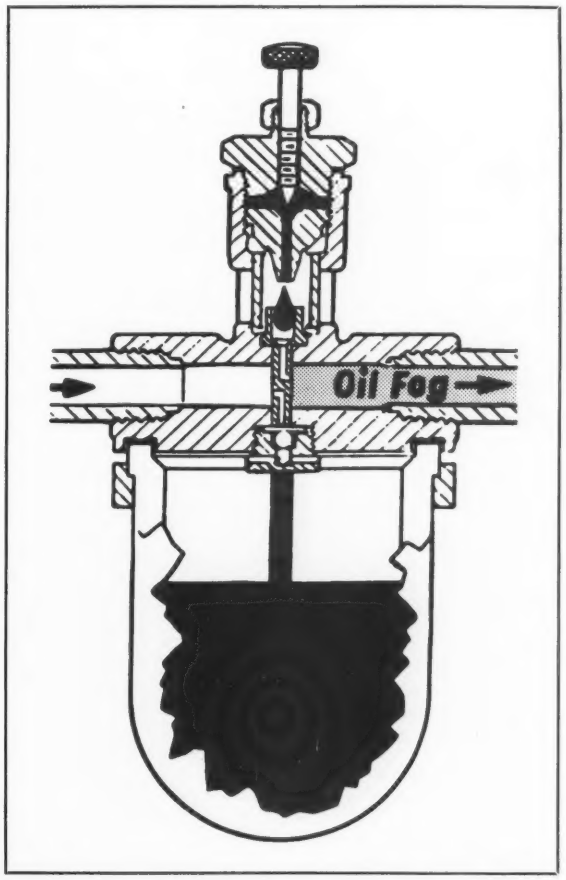


Fig. 1. Oil-Fog Lubricator Principle

This particular device embodies in the oil circuit a check value to hold the oil in the conveying passages during inoperative periods, a needle valve adjustment to control the flow of the oil, a sight-feed chamber for observing the rate of oil feed. It is so designed that the oil supply can be replenished without shutting off the compressed air supply.

Depending upon the manufacturer, there are many configurations of this basic device. However, the fundamental consideration irrespective of construction is the fact that all of the oil being fed by the lubricator directly enters the air line, and the fog produced by such devices consists of a wide range of individual particle sizes.

Lubricators of this fundamental type are suitable for the lubrication of air-operated equipment where only one or possibly two pieces of equipment are connected to any one lubricator.

The second basic type is illustrated in Fig. 2. It is illustrative of the second fundamental principle. Oil is drawn from the oil reservoir into the venturi section by means of the pressure drop created by the flow of air through the venturi. In this respect, it is identical to the previously described device; however, here the similarity stops. The oil fog created by this device is created in a downward direction into the upper regions of the oil reservoir. Approximately 90% of the oil fog thus formed is permitted to return to the oil reservoir, and only 10% of the oil fog enters the compressed air system. The fog which enters the air system is of a very small and uniform particle size in the range of 0.5 to 2.0 microns and is truly an air-borne fog. It can therefore be conveyed through intricate piping systems over long distances and emerge as a fog.

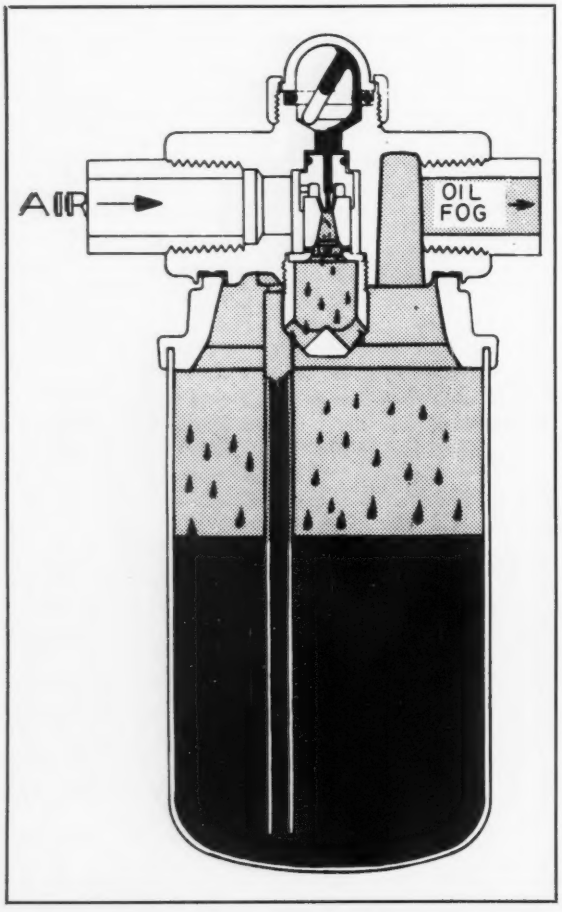


Fig. 2. Advanced Lubricator Principle

This particular device embodies in the oil circuit a sight-feed dome to permit observation of the rate of oil feed. The oil-feed control is obtained by means of a needle valve in an auxiliary air circuit, affording more reliable and accurate means of oil-feed control than the needle valve in the oil circuit. Depending upon the application and need for such features, lubricators of this type may also include a constant-level oil device to make the function of the lubricator entirely independent of the oil level in the reservoir and/or an adjustable venturi which will permit setting the venturi for optimum performance over a wide range of air-flow conditions.

For the present purpose, however, the important consideration is the fundamental difference between this lubricator and the one previously described; namely, this lubricator discharges into the compressed air system only a selected portion of the oil fog, that portion which is of high quality and relatively uniform particle size. This type of lubricator is used for the lubrication of air-actuated equipment and for centralized lubrication systems employing large, complex distribution systems for the lubrication of machine-tool components. In order to properly select such a lubricator, the end usage must be known in advance so that the internal components of the device are suitable for the purpose.

AEROSOL MACHINE TOOL LUBRICATION

The use of aerosol lubricators for the lubrication of air tools and other air-operated components is today standard procedure throughout industry. The benefits to be derived therefrom are well recognized. It has been proved beyond doubt that properly lubricated equipment operates more efficiently, lasts longer, and requires less maintenance; therefore, it is today indeed the exception to see an installation of air-powered equipment without the benefit of an aerosol lubricator. There seems to be no necessity to dwell on this phase of the subject, but rather to devote the discussion to aerosol lubrication as it applies to machine-tool components such as bearings, gears, chains, etc.

System Design

It is often thought that the design and installation of an aerosol lubrication system is complex and difficult. This, however, is not true. The system design manuals which are available from manufacturers of this type of equipment appear to treat a complex subject and to use them would seemingly require the digestion of a considerable amount of complex data. As is so often the case, the written treatment of a subject gives it an air of complexity when, in reality, the underlying theory and approach to the problem is quite simple.

To select the proper aerosol lubricator, it is necessary to have some measure of the quantity of lubrication required. This varies from one piece of equipment

to the next, depending upon the number and size of bearing surfaces to be lubricated. The term "bearing inch" is the unit of measurement used for this purpose. By means of a simple calculation, the bearing-inch rating of any type of bearing surface can be established; and the total of these individual bearing-inch ratings for any given piece of equipment is a measure of the total lubrication requirement.

The available design manuals provide a step-by-step procedure for determining the bearing-inch requirement. Having once followed through this procedure, any subsequent system designs will prove to be quite simple.

What is a bearing inch? In its simplest form, the bearing inch is the shaft diameter of a single-row antifriction bearing. Example: A single-row ball bearing, fitted to a 1-inch diameter shaft represents one bearing inch. If it were fitted to a 2-inch diameter shaft, two bearing inches. For a two-row bearing, the values are doubled. Example: A two-row ball bearing fitted to a 1-inch shaft represents two bearing inches.

For futher illustration, consider a plain bearing. The bearing-inch rating of a plain bearing is ¼ the projected area of the bearing. Example: Consider a plain bearing 2 inches in diameter, 4 inches long—the projected area of the bearing would be $2 \times 4 = 8$ square inches; $8/4 = 2$ bearing inches.

Equally simple approaches to the determination of bearing-inch requirements of other machine components will be found in the design manuals. After establishing the bearing-inch requirement for each of the components to be lubricated, the sum of these individual requirements represents the required rating of the aerosol lubricator to be used. Except for very large equipment having a requirement in excess of 1,000 bearing inches, there is available a lubricator which will suit the requirement.

The next consideration is the selection of oil-reservoir capacity which best suits the established maintenance schedule. Using an estimated rate of oil consumption of .02 fluid ounces of oil per hour per bearing inch provides a good "rule of thumb" method of estimating the frequency with which the lubricator must be refilled. In actual practice, there is a considerable variance from this figure, due to a multiplicity of variable operating conditions which at this design stage, are unknowns. A great variety of reservoir capacities are available, ranging from 0.4 fluid ounces to 2.2 gallons working capacity.

Research, as well as practical field experience, indicates that it is essential to use a reclassifier at each point of lubricant deposition. This view, however, is not shared by all manufacturers of aerosol-lubrication equipment.

The reclassifier fitting serves as a means to connect the aerosol line to the point of application; and, by the nature of its design, it increases the individual oil-fog particle size introduced to the bearing, thus assuring better deposition of the oil, better lubrication of the bearing, and elimination of atmospheric contamination. The reclassifier also serves to properly proportion the lubricant to each bearing surface, depending upon its requirements as established by the bearing inch rating.

There are many styles of reclassifiers to provide convenience of installation. Reclassifiers should be selected for each component to be lubricated, based upon the previously calculated bearing-inch requirement for the component. Tables providing this information are set forth in the previously mentioned design manuals.

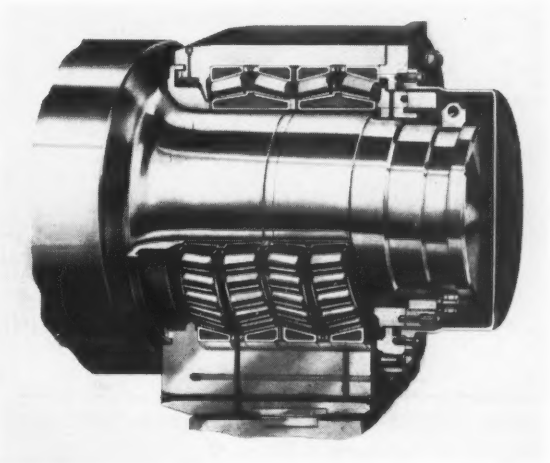


Fig. 3. Roll-Neck Bearing

Fundamental Components of an Aerosol-Lubrication System

The available plant air supply is generally the source of compressed air for an aerosol-lubrication system. This air supply is usually at a pressure of approximately 90 psi. and contains contaminants such as dirt, pipe scale, condensate, compressor oil residues, etc. Therefore, suitable processing of the air is necessary before it is introduced to the lubricator.

A good *air-line filter* and *pressure regulator* must be used immediately ahead of the aerosol lubricator. The filter should preferably be one of the automatic-dumping type. This relieves the operating personnel of the necessity of manually draining the condensed liquids from the air-line filter.

The pressure regulator permits the adjustment of the pressure so that the lubricator can be operated at optimum efficiency for the particular application, remembering that on this type of application, low air-flow rates are employed and high concentrations of oil fog in air are desired; therefore, control of the operating pressure is essential.

There are four essential basic components in an areosol-lubrication system, Fig. 4;

1. Efficient Air-Line Filter—preferably of the automatic-drain type
2. Pressure Regulator—for the accurate control of the pressure applied to the aerosol lubricator
3. Aerosol Lubricator—of suitable oil-output and reservoir capacity to satisfy the requirements of the installation

4. Reclassifiers—for each application point, appropriately selected, based upon the bearing-inch requirements of the component to be lubricated

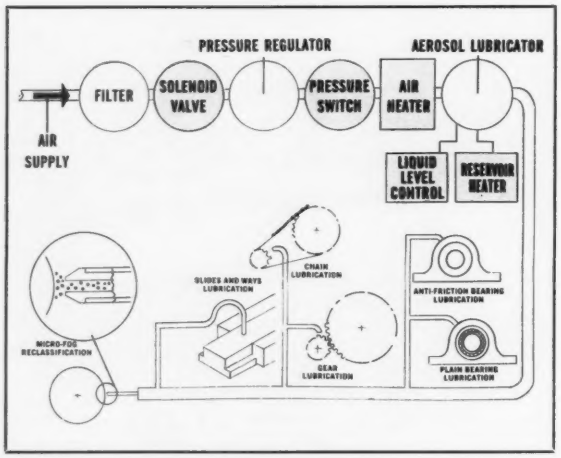


Fig. 4. Components of an Aerosol-Lubrication System (Essential & Auxiliary)

Auxiliary Equipment

On many applications, it is desirable to incorporate into the systems some auxiliary devices for convenience of operation and the protection of the equipment.

1. A solenoid valve is often installed between the filter and regulator and connected to the equipment controller so that the lubrication system is automatically operated in conformance with the equipment operating cycle.
2. A pressure switch is frequently used between the pressure regulator and the aerosol lubricator to detect failure of the air supply. The pressure switch can be used to operate an alarm device or connected into the equipment controller so as to shut down the equipment in the event of air-system failure.
3. A liquid-level control can be installed in the aerosol lubricator to avoid the possibility of undetected depletion of the oil supply. This control can be connected to an alarm device or to the machine controller, thus avoiding the possibility of operating the equipment with inadequate lubrication.
4. On some models, a thermostatically controlled heating unit can be attached to the oil reservoir to maintain a more uniform lubricant temperature. The heater is particularly valuable in locations where there are large ambient temperature changes.
5. A preheater for the compressed air—By heating the air before it enters the lubricator, it is possible to successfully apply higher viscosity lubricants.

TYPICAL APPLICATIONS

Centralized lubrication systems, utilizing aerosol principles, are used today on practically every type of industrial equipment known to industry. In the process of pioneering this technique, there have naturally been some unsuccessful installations; however, the successful installations far outweigh the failures. Most of the installations which initially failed to perform up to expectations have been corrected and are providing outstanding performance. Some few, through lack of know-how at the time or impatience of the personnel involved, were discarded and considered to be unsatisfactory.

The day of experimentation with aerosol-lubrication techniques is over. The large number and variety of applications have yielded a wealth of application data which makes it possible to approach any new problem confidently.

It is impossible to give here a complete resumé of all of the uses of aerosol lubrication; however, the range covers everything from small, high-speed turbo-driven dental handpieces, operating at 250,000 rpm (1,000,000 rpm experimentally) to four-row rollneck bearings fitted to 34-inch diameter shafts. Illustrations, Figs. 5 thru 11, are representative of some of the equipment which is today being lubricated by aerosol-lubrication techniques.

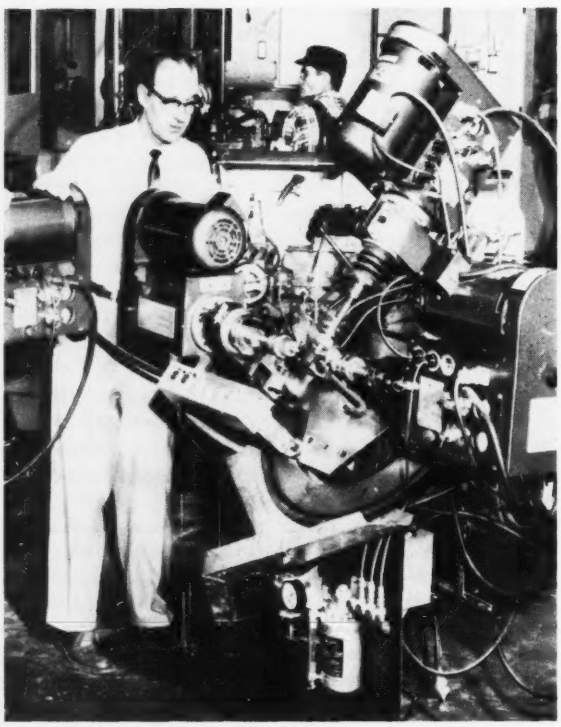


Fig. 5. Drilling & Tapping Machines

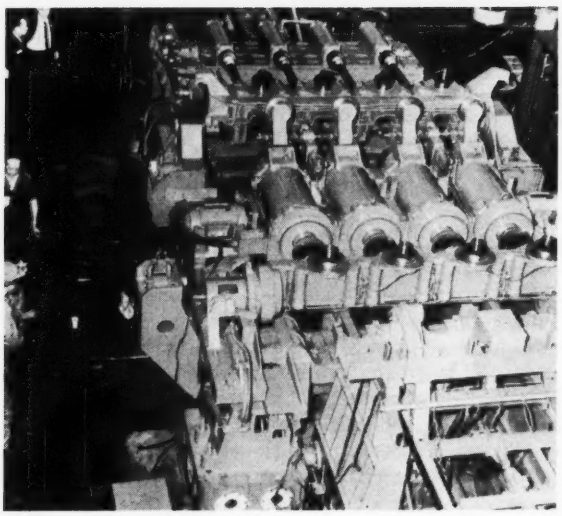


Fig. 6. Rollocast Machine

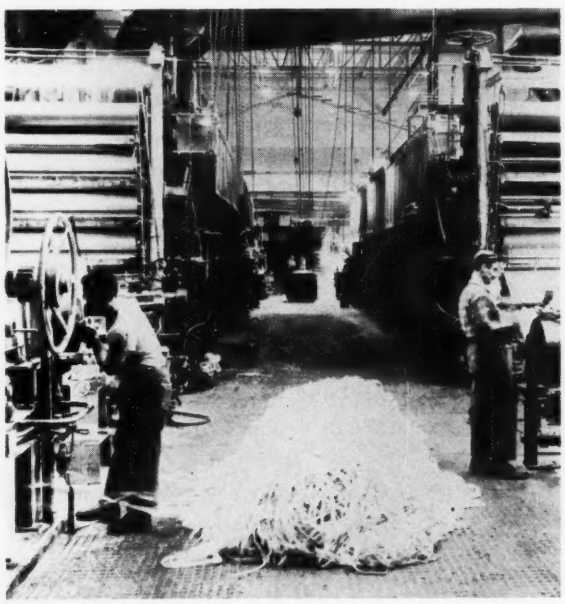


Fig. 7. Paper Dryers

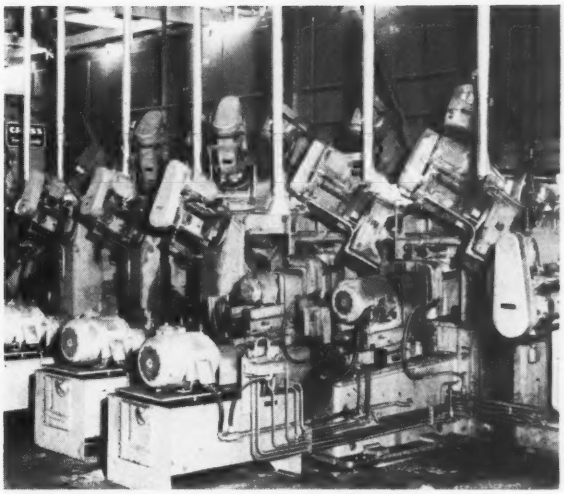


Fig. 8. Transfer Machine

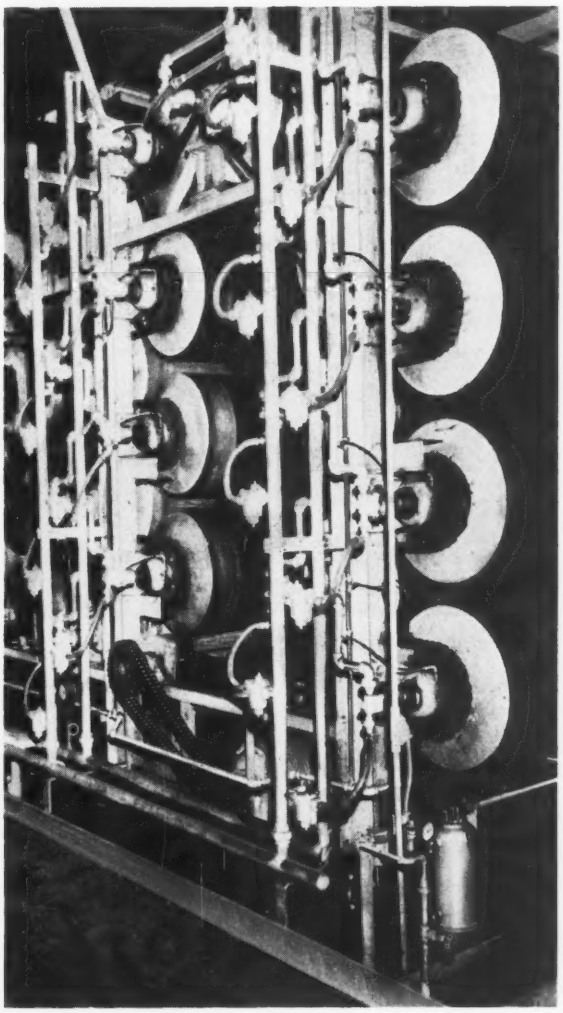


Fig. 9. Dry Can Stack

Fig. 10. Rod Mill Run-out Table

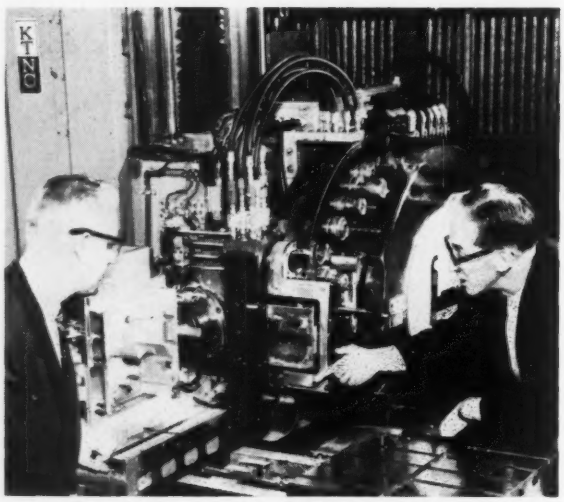


Fig. 11. Automatic Multiple-Process Machine Tool

THE FUTURE

Industry is naturally desirous of taking advantage of any equipment which offers the possibility of improved performance. Aerosol lubrication is a relatively new lubrication technique offering many advantages and the solution to many difficult lubrication problems. It can therefore be expected that more and more equipment throughout industry will utilize aerosol-lubrication techniques and equipment.

It, of course, must be understood and recognized that this type of lubrication is not the most logical answer to every lubrication problem. For some applications, aerosol lubrication offers some very definite and outstanding advantages over other known lubrication techniques. In other instances, it is a toss-up as to which to use; and, in still others, aerosol lubrication is at a disadvantage. It is difficult, if not impossible, to write a set of rules for the selection of lubrication systems. There are numerous considerations, both finite and abstract. Consultation with qualified personnel is highly desirable.

In the years ahead, there will unquestionably be improvements in aerosol-lubrication devices. These will be stimulated by application problems and by the desire of the manufacturers of this type of equipment to offer industry the best equipment possible to most economically and efficiently achieve the purpose. This is fundamental within the structure of the competitive situation in which industry operates. There will unquestionably be an increase in use of this type of equipment. It is a technological advance, and progress cannot be stopped.

REFERENCE

1. Faust, D. G., "Oil-Fog Lubrication," *Lubrication Engineering*, Vol. 8, No. 4, August, 1952.
2. Faust, D. G., "Fog Lubrication of Machine Tools," *Lubrication Engineering*, Vol. 14, No. 2, February, 1958.

Conveyor Lubricators for

Automatic Lubrication

An evaluation and explanation of this specialized field of automatic lubrication of moving points on conveyors, pallets, trucks and etc. in both application and responsibility.

Conveyor Lubricators, as a method of Automatic Lubrication, has not reached its full potential due to varied reasons such as:

Distorted or incomplete knowledge of what can be done to automatically lubricate conveyors and how it is done.

Incomplete evaluation of potential cost reductions.

The lack of clearly defined areas of responsibility.

It is the intention of the author to equip the reader with a working knowledge of the potentials of automatic conveyor lubrication, acquaint him with the various types of equipment available and illustrate through substantiated case studies the expected cost of automatic conveyor lubrication and what to expect in return.

by William M. Peterson
Chief Engineer
Olsen Manufacturing Co., Inc.
Royal Oak, Michigan

DEFINITION: AUTOMATIC CONVEYOR LUBRICATOR

What is an "Automatic Conveyor Lubricator"? The term, "conveyor lubricator" is defined as "a practical mechanism for efficient lubrication of such moving parts during the normal movement of same and without disturbing the operative functions of the equipment being so lubricated". To complete this definition for "automatic" add "and with a minimum amount of resources".

The term "conveyor", as used in conjunction with the phrase "automatic conveyor lubricator" does not limit its application to the endless chain type conveyors. The automatic conveyor lubricator, as discussed herein, is a device to automatically lubricate any moving point that is traveling within a defined area.

Such devices, as defined above, are not a product of the present day highly mechanized and automated manufacturing plants.

A brief investigation of automatic lubricators, pertaining to conveyors and similar equipment, indicates that such devices were in use at the turn of the century. These automatic conveyor lubricators, of the early nineteen hundreds, are strikingly similar in principle and application to those in use today.

Presented at the 16th ASLE Annual Meeting in Philadelphia, Pa., April, 1961.

POTENTIAL

To fully realize the potential of automatic conveyor lubrication, one must have the following basic information:

Costs of manual lubrication?

- Direct labor?
- Down time (for lubrication)?
- Maintenance and repair due to lack of lubrication?
- Down time (lost production)?

In many cases the last item, down time lost production, is by far the most costly yet the most difficult to credit. In many cases said costly breakdowns can be traced to lack of proper lubrication.

Next in line one must evaluate his lubrication problem in:

- Can lubrication be performed automatically?
- How and with what?

The possibilities of automatic lubrication, while still limited, is ever increasing. What is available for automatic conveyor lubrication and the types are discussed further in this article.

After determining if you can lubricate automatically and how, you must know:

- Cost of equipment and installation?
- Cost of operation and maintenance?

These costs, including case studies, are further discussed.

The potential cost savings in automation are fantastic. Automatic lubrication of conveyors and other

material handling equipment is like automating the automation.

With the great role that material handling equipment plays in today's industry, maintenance and repair of equipment after it has gone down is not adequate. Preventive maintenance is the only answer.

Preventive maintenance must be automatic and wherever possible, with automatic equipment.

Automatic lubrication performs not only the obvious function of lubrication with a minimum amount of resources, it is also an insurance policy; an insurance policy against costly lost production.

TYPES

Devices to automatically lubricate conveyors or similar equipment vary, depending on the equipment to be lubricated, the lubricant, material being conveyed, conditions either hot, cold, clean, dirty, etc., and frequency of lubrication, to mention a few. The following is a brief description of some of the standard units offered industry.

(A) Injection Type—The injection type engages a passing fitting or open port located on a wheel hub, shaft end or similar point. Upon engagement of the lubricant point the injection nozzle seats and seals on the fitting and injects a measured amount of lubricant, either oil or grease, under pressure. This type of lubricator duplicates the operation of a manually operated grease gun.

The mechanisms of this type of lubricator vary, depending on the manufacturer; however they are similar in the following respects.

Nozzles may be used of the single reciprocating type, which return to their starting position after each injection, or multiple injection nozzles mounted on a rotating turret with the turret rotation moving the following injection nozzle into pick up position (see Fig. 1). Where speed is of importance, the rotating turret has the advantage, in that no time or motion is lost setting up for the next injection.

The lubricating heads are positioned to commence the lubricating cycle either manually or by the use of air cylinders. Where the lubricator is installed in an inaccessible location, or when it is to be automatically controlled, the air cylinder positioning is advantageous in that it may be remotely controlled.

The lubricant is metered by a mechanical, air or hydraulic operated metering valve. Usually the amount may be adjusted. Some models now offered for heavy industry have a maximum adjustment of one (1) cubic inch per injection. This large amount of lubricant is advantageous where flushing of the bearing is required and eliminates the need for several passes.

The lubricant is pressurized in several ways. One such method involves the use of an air operated booster combined with the metering valve. The pressure is obtained through a size ratio between the lubricant and air pistons. Ratios as high as 20 to 1 are available on some standard models now offered. Another method of pressurizing the lubricant is from a drum under high pressure through a metering valve located on the lubricator. Considerable higher pressures may be obtained this way (a ratio of 40 to 1 is not uncommon). Where high pressures are not required, direct air loaded reservoirs are available. It should be pointed out that different applications and conditions may require different injection pressures.

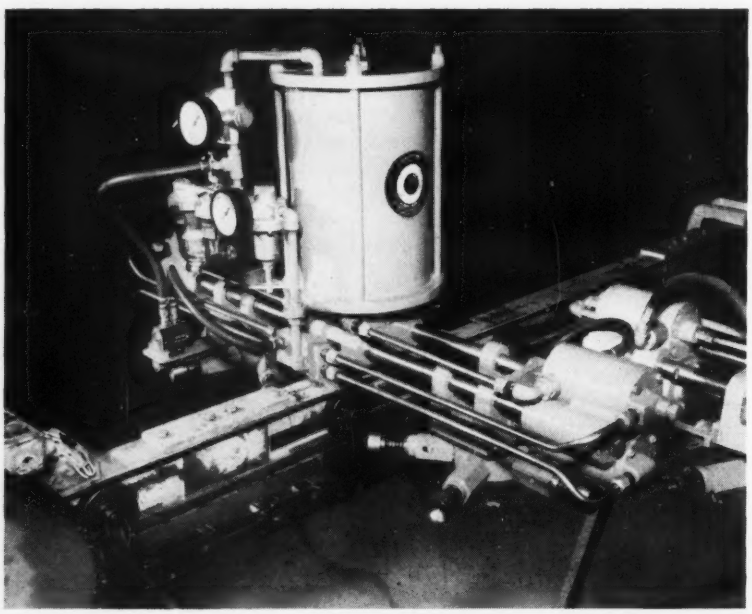


Fig. 1. Injection Type Automatic Conveyor Lubricators installed on monorail type conveyor. Five nozzle turret heads are shown disengaged (pulled back)

The lubricant may be supplied from a drum pump as described above or from reservoirs mounted directly on the lubricator. The latter is usually air or spring loaded to insure flowage of the lubricant into the metering device. Where frequent lubrication is required, the drum feed is advantageous, requiring less refilling and also less chance of lubricant contamination. Also, one drum pump may be used to feed several lubricators.

Actuation (to inject the lubricant) is obtained several ways. One such method is the movement of the engaged nozzle actuating a hydraulic or air cam valve, which in turn actuates the metering valve or booster at the moment the injection nozzle is properly seated. Other emthods are cam valves or limit switches actuated directly by the approaching lubricant point.

(B) Spray Type—The spray type can be broken down into two (2) distinctive types. These types would be the air-oil mix and the solid oil.

The Air-Oil Mix may be further broken down into two (2) types. The first is that which uses an air and oil mixing chamber ahead of the spray head or nozzle. This results in a spray very similar to a mist. The advantages of this type are that the many small particles of oil suspended in the air stream are of such minute size that they penetrate very small openings. The disadvantages are that, oil so suspended and of minute size, can float or travel great distances in air currents and may result in product contamination.

The second air-oil mix type is that which mixes the air and oil in the nozzle or at a point where the oil and air leave the nozzle or spray head, (see Fig. 2). This type may have the oil either gravity fed or pressurized. It is possible with this type to spray heavier oils than with that which mixes the air and oil prior to entry of the spray head. This type can produce a spray with a wider range of density and spray patterns.

Air-oil spray lubrication is a very effective means of lubrication. When the point to be lubricated is at all accessible, such as chain rollers and pins, open trolley and wheel bearings, etc., a properly installed air-oil spray will almost immediately reach all points and thereby provide complete and instant coverage.

Disadvantages are that it is limited to light and medium oils. Probably the most important disadvantage is that of product contamination. The amount of contamination depends on the type used. Even though this contamination or "over spray" can be kept at a surprisingly low level with proper application, is is always present. Before selecting this type of automatic conveyor lubrication this should be thoroughly considered as to whether or not it will be a problem. The air-oil types are available in both a continuous or intermittent spray actuated by a limit switch, cam valve or timer.

Solid Oil Spray is the second type of spray. This type is where the lubricant is injected through a nozzle under pressure without air as a carrier. Heavy oils, as well as light grease, may be applied in this manner.

The most common means of pressurizing the lubricant is with a high pressure pump feeding several metering valves or a piston pump with the pump also acting as a metering device.

Either type, the piston pump or metering device, is usually a part of or adjacent to the spray head, and offers an intermittent spray only.

Advantages are that heavier lubricants may be applied, wide varieties of spray patterns are available, extreme accuracy in applying the lubricant to a point without actual contact by the nozzle and greatly reduced "over spray".

Disadvantages over the air-oil mist spray are that it is generally more costly, moving parts are required and a continuous spray is not available.

(C) Wiping, Blotting, or Brushing—This type covers such devices as stick lubricants, felt rolls and brushes.

The stick type applies a solid lubricant as it is rubbed along the point to be lubricated. It requires a comparatively smooth surface to be applied to as considerable roughness or breaks in the surface result in excessive usage, or in many cases, breakage.

The blotting type example would be the felt roll (see Fig. 3), the oil is applied to the roll which, upon being saturated, blots the lubricant off onto the point being lubricated as it rolls over the surface. A slightly irregular surface, such as a chain, may be lubricated in this fashion. Severe irregularities in the surface result in increased wheel wear.

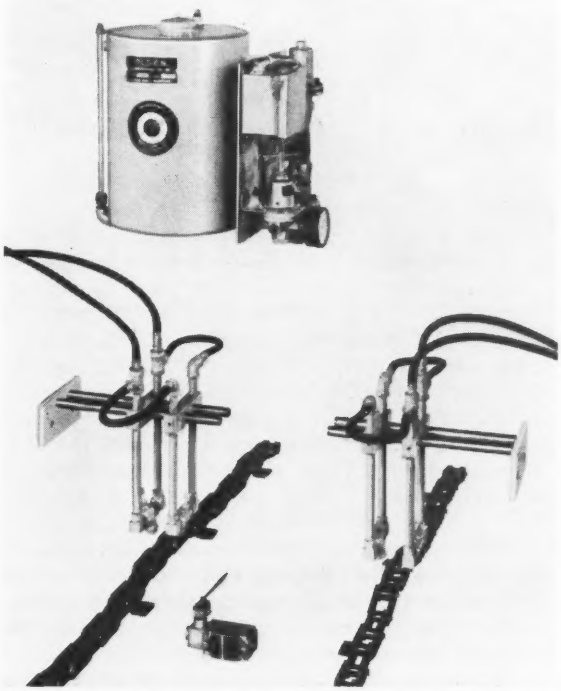


Fig. 2. Air Oil Spray Lubricator. Model illustrated mixes air with the oil in the nozzle with the oil being gravity fed to the nozzle. A solenoid valve, limit switch controlled, provides an intermittent spray.

The brush type, usually a fiber brush, is also saturated with oil and brushes the lubricant onto the surface. More irregular surfaces may be lubricated in this manner. Also graphite type lubricants may be applied with a brush while application with a felt roll results in glazing of the roll. A disadvantage of the brush is that application is not as positive as that of the felt roll.

Probably the greatest disadvantage of both the felt roll and brush is that of over application. Both, when properly adjusted, can perform a very satisfactory lubrication job. Once the chain or rail has made a pass or turn, the lubricant should be reduced to replace only that lubricant which was used.

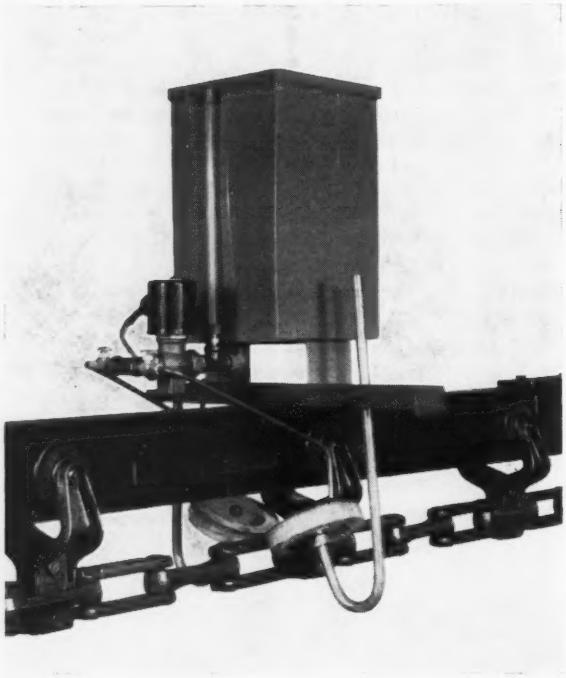


Fig. 3. Felt roll oiler or blotting type lubricator lubricating a conveyor chain.

SUMMARY OF TYPES

Of the three basic types discussed (A) Injection, (B) Spray, and (C) Wiping, Blotting, and Brushing, the Injection type is the most positive when applicable. It will apply a measured amount, under pressure, through a fitting or port.

The Spray type would be second, also applying the lubricant under pressure, yet over a broad area on a catch all basis.

The Wiping, Blotting, or Brushing types would be the least positive of the three, depending on physical contact of the point to be lubricated with the moving point to scrape, blot or wipe the lubricant off the applicators.

Cost of both the initial installation as well as maintenance would run in the same order with the injection type being the most costly to install and maintain. This is due primarily to the complexity of the device.

It is not the intention of the author to be complete in his listing of types, their features or functions. It is intended only to present a working knowledge of what is available and what to expect of it. There are other types available that were not discussed, generally these are basically the same or are a combination and variation of those discussed.

The important fact is that there are several different and specialized types offered industry. Each application should be thoroughly investigated and evaluated on the points discussed and then the proper means of applying automatic lubrication selected.

Manufacturers of automatic conveyor lubricators are continually developing methods of lubricating automatically points that heretofore have been inaccessible.

Much existing material handling equipment was designed and installed with no consideration to automatic lubrication or, for that matter, to manual lubrication. In many cases alterations can be made to this equipment to make it adaptable.

CASE STUDIES

As an aid in determining costs and expected return on investment for automatic conveyor lubrication, some substantiated case studies of existing installations are cited.

These typical installations are broken down into two categories as follows:

Heavy Industry—Includes steel mills, foundries, ore processing plants, and etc.

Medium Industry—Includes automotive, appliance and etc.

Costs used are actual material costs including lubricators, necessary accessory equipment, and four dollars ($4.00) per hour on labor. Labor savings and return on investment are over a one (1) year period. Allowance is made in labor savings for maintenance and service of the automatic lubricators as required.

Heavy Industry

(A) Industry—Steel Mill, Midwest
Type of Conveyor—Sinter Machine
Material—Sinter
Conditions—Extreme heat and ore dust
Type of Automatic Lubrication—two (2) injection type lubricators to lubricate wheel bearings on each side of pallet
Cost of Installation—$2,150.00
Labor Savings—$3,328.00
Return on Investment—154%

(B) Industry—Foundry, Midwest
Type of conveyor—Flask Cooling Conveyor
Material—Flasks, from pouring of casting to dumping of flasks
Conditions—Extreme heat and foundry sand
Type of Automatic Lubrication—One (1) Injection Type lubricator to lubricate hinge pin between pallets
Costs of Installation—$1,070.00
Labor Savings—$2,496.00
Return on Investment—225%

(C) Industry—Steel Mill, Midwest
Type of Conveyor—Apron Conveyor
Material—Hot Sinter Fines
Condition—Outside in extreme sinter and ore dust
Type of Automatic Lubrication—two (2) injection type lubricators to lubricate wheel bearings on each side of the conveyor
Cost of Installation—$2,215.00
Labor Savings—$9,360.00
Return on Investment—422%

Medium Industry

(A) Industry—Automobile, body plant, Midwest
Type of Conveyor—Overhead monorail type
Material—Automobile body sections
Conditions—wash, bonderite, paint and drying
Type of Automatic Lubrication—One (1) double head injection type to lubricate the trolley bearings on each side of the rail
Cost of Installation—$956.00
Labor Savings—$1,144.00
Return on Investment—120%

(B) Industry—Automobile, body plant, Midwest
Type of Conveyor—Floor Truck
Material—Automobile bodies
Conditions—dirty
Type of Automatic Lubrication—One (1) double head injection type to lubricate the trolley bearings on each side of the rail
Cost of installation—$1,650.00
Labor Savings—$16,016.00
Return on Investment—970%

(C) Industry—Automobile assembly, Midwest
Type of Conveyor—Floor Conveyor
Material—Automobile final assembly
Conditions—Clean
Type of Automatic Lubricator—One (1) double head injection type to lubricate the trolley bearings on each side of the rail
Cost of Installation—$1,200.00
Labor Savings—$1,664.00
Return on Investment—$138%

(D) Industry—Appliance, Northeast
Type of Conveyor—Overhead monorail, fifteen (15) conveyors being serviced by one portable lubricator
Material—Refrigerator bodies and panels
Conditions—Clean
Type of Automatic Lubricator—One (1) double head injection type to lubricate the trolley bearings on each side of the rail
Cost of Installation—$1,800.00 ($120.00 per per conveyor)
Labor Savings—$2,520.00
Return on Investment—140%

An extensive survey, comparing the average costs and return on investments of automatic lubrication in the two types of industry, shows the following:

TABLE 1
COMPARATIVE COSTS AND RETURNS ON INVESTMENTS

	Cost per point Lubricated	Return on Investment
Heavy Industry	$1,111.00	222%
Medium & Light Industry	610.00	288%

The cost of automatic lubrication per point in heavy industry is approximately twice that of medium or light industry. This is to be expected due to the equipment used, even though identical in function, it is necessarily heavier in construction and requires protective features not generally required in medium or light applications (see Fig. 4).

The percent of return on investment is less for the heavy industry installation. This figure is somewhat misleading due to the real return being in reduced repair and down time costs. The average installation in medium or light industry duplicates a lubrication program previously manually performed. The return on the investment is therefore a direct result of this labor savings. Heavy industry installations generally differ in that they are performing a function that *could not* be performed manually. Due to the heavy loads, extreme dirt and heat, lubrication requirements are more frequent or continuous.

In reality, the return on investment for automatic conveyor lubrication in heavy industry is greater when the savings of reduced repair and down time can be accounted for. An example of this is Case Study (C) of Heavy Industry, where down time and maintenance savings were accounted for and a return on the investment of 422% was realized. In the other case studies this figure was not available.

Case Study (B) of Medium Industry is the exception rather than the rule. Here extreme operating conditions necessitated continuous lubrication. This was previously performed by two men, each working a full shift, yet complete and adequate lubrication was not obtained. This was evident when a substantial decrease in breakdowns was realized after installation of automatic lubricators.

Portable automatic conveyor lubricators such as in case study (D) of Medium Industry, while greatly

reducing the initial cost per conveyor, are not necessarily the solution to all applications. They are advantageous only where lubrication schedules are not severe, such as every two weeks to several months and where all the conveyors to be serviced are similar.

Generally, portable automatic conveyor lubricators can be installed and operated during normal production hours thereby eliminating costly overtime.

Installation costs of spray type lubricators run proportional in the two types of industries and approximately seventy-five percent (75%) less. Labor savings are likewise proportional to costs and higher. Adequate lubrication of chains operating under extreme conditions can increase the life of both chain and sprockets many times.

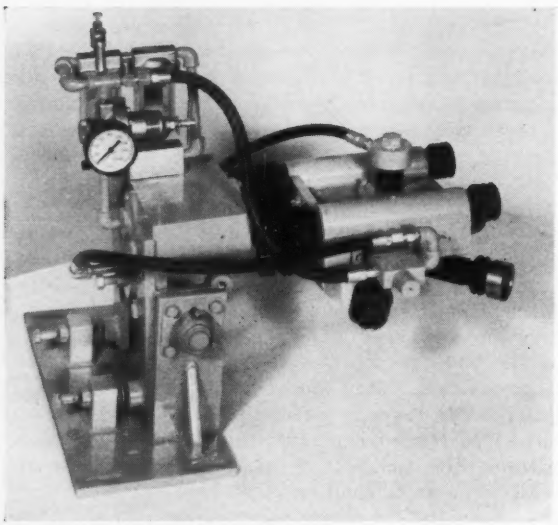


Fig. 4. Injection, Turret Type Automatic Conveyor Lubricator for Heavy Industry. All working parts are enclosed in heavy cast iron housings with exposed rods and nozzle spools protected by rubber boots.

RESPONSIBILITY

The Automatic Conveyor Lubricator

To duplicate a manual operation with a machine is also to accept the responsibilities of the person or persons who previously performed this operation.

Automatic conveyor lubricators must not only accept this responsibility, but in many cases, must improve upon it.

This tremendous responsibility must be fully realized and accepted by the manufacturers of automatic conveyor lubricating equipment. The user of his product is entrusting his production and material to the proper functioning of the lubrication equipment.

Such devices should not be considered a gadget. Sound and constructive engineering and design must be the basis of their conception and application, while quality in manufacturing comparable to the responsibility accepted is a must.

THE CONVEYOR

Herein, perhaps, lies one of the largest stumbling blocks to the application and acceptance of automatic lubrication.

Until recently, little, if any, thought to adaptability to automatic lubrication was given to the design of conveyors and similar material handling equipment. Even now there is little consideration, let alone actual constructive practice, given to this problem.

As is the part of the lubricator manufacturer in furnishing dependable equipment, the designers and builders of conveyors must recognize the importance of adaptability to automatic lubrication.

An example of this inadaptability is the type of lubricant fitting. There are several types of lubricant fittings available; some of these were designed specifically for manual lubrication requiring the injection nozzle to lock on the fitting. This type of fitting, generally not adaptable to automatic lubrication, will require replacement.

The use of flush or semi-flush fittings, because of clearance, is another problem. In many cases an extended fitting is required to not only locate but to properly seat and seal the injection nozzle. In most cases adequate clearance for extended fittings can be easily provided in design. Protection of these fittings from other sources of damage can also be provided.

Fittings should be located at an accessible point and at a position that is constant. Fittings have been, and are, located off center on rotating wheels or shafts. The problems of this in automatic lubrication are obvious. Other fittings, even though fixed or constant, are in inaccessible locations.

Generally, adaptations can be made to either the lubricating device, the fitting, or the location of the fitting to facilitate automatic lubrication. Regardless of whether such adaptations are possible or not, the cost of such alterations must be considered. In many cases this additional cost is such as to prohibit the use of automatic lubrication and thereby eliminate the possibility of reduced maintenance and production costs available.

USER

Last but not least is the responsibility of the user.

His first responsibility is in recognizing the potential savings through automatic lubrication.

Secondly, he must select the proper equipment for the application. This not only involves the type of lubricator, whether it be injection, spray or etc., but also equipment that was designed and built for his specific type of application. Automatic conveyor lubricators, like conveyors, are designed and built for the load they are expected to handle and conditions they will operate under.

Should new material handling equipment be required, it is also the user's responsibility to specify it be adaptable to automatic lubrication.

An automatic conveyor lubricator, like any mechanical device, must be maintained. To lubricate automatically is a big step in releasing man from monotonous chores, yet the lubricators can not be completely ignored and expected to function forever. Conveyors shift or change their tracking due to varying loads, temperature changes and even materials used in their construction. Because of this, the automatic lubricators should be inspected periodically (each operating cycle if possible) to insure proper engagement and adjust if necessary. The lubricators are subject to wear, depending on the conditions they are working under, and should be maintained accordingly. Readjustment, if required, periodic cleaning and replacement of worn parts are necessary if they are expected to perform their functions efficiently.

This is by no means meant to overshadow the responsibility of the automatic lubricator, yet all too often such devices, their original savings in reduced maintenance costs soon forgotten, fail through complete neglect.

SUMMARY

By definition, it has been determined what is an automatic conveyor lubricator.

It is also known that such devices have great potential in reducing costs of both maintenance and lost production and material.

Automatic lubrication not only reduces direct costs, releases valuable manpower for more complex or technical assignments but also offers an insurance policy against breakdowns and lost production.

Various types of automatic conveyor lubricators have been described, and their basic advantages and disadvantages discussed. This description of types, while not complete, will better acquaint the reader on what is available and where it might be applied to the best advantage.

To better illustrate various applications, case studies of injection type lubricators in both heavy and medium industry were cited. From these it was determined that cost of applications in heavy industry is approximately twice that in medium or light industry. It was also determined that the average return on investment over a twelve month period was in excess of two hundred percent (200%) regardless of industry type.

Cost savings due to automatic conveyor lubrication in medium and light industry is generally due to savings in labor alone. Heavy industry, while showing a slightly less but substantial labor savings, shows its greatest payoff in reduction of repair and lost production.

The responsibilities of the manufacturers of automatic conveyor lubricators is defined as that of furnishing equipment capable of accepting the responsibility which is entrusted in it. He must furnish equipment that is equal to the application and will function as dependably as possible under the operating conditions required.

The role of the conveyor and material handling equipment manufacturer is that of furnishing equipment that is adaptable to automatic lubrication.

The user, to realize this proven means of cost reduction, must be familiar with what is available in automatic conveyor lubrication. Once having adapted this mechanized means of preventive maintenance, he must service and maintain this equipment to realize its full benefits.

In today's highly mechanized methods of manufacturing, the importance of positive and efficient maintenance is playing an ever increasing role. The efficient use of automatic conveyor lubrication is a tried and proven method of delegating this responsibility and in so doing, reduce operating costs.

A Survey of Lubrication Methods

Part 3- Compendium of Lubricating Devices

(CONCLUSION)

by Allen F. Brewer*
Consulting Editor

Illustrated by Robert R. Wayne
Pittsburgh, Pa.

In the present article the discussion of centralized systems will be concluded. As in the previous articles of the series, the illustrations have been kept schematic to stress the principle of operation rather than the details of construction.

INDIRECT SYSTEMS

There are four basic types of indirect systems in common use that differ from one another by type of metering valve required or by the configuration of the lubricant transmission line. In the preceding article of this series, two indirect systems were discussed, the single-line-spring-return system and the two-line system. These systems are often called parallel systems since the individual metering valves are connected to the supply lines in a manner that permits each valve to be operated independently of the other valves in the line. In the present article, two systems which are sometimes called series systems will be described. In a series system, the metering valves operate progressively in a set sequence. Both series systems to be discussed are of the single-line variety.

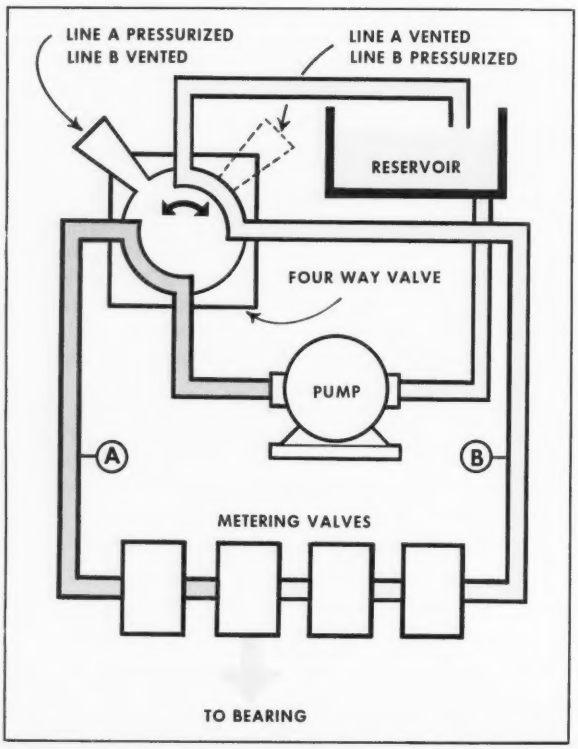


Fig. 29. Series System with Reversible Flow

*Consultant and author, "Basic Lubrication Practice."

Series System, Reversible Flow:

Fig. 29 illustrates schematically the series system with reversible flow. The pump supplies lubricant under pressure through a four way valve to a supply line to which a number of metering valves are connected in series. With the four way valve in the position shown, the portion of the line marked "A" is pressurized and the portion marked "B" is vented to the reservoir. Lubricant first enters the metering valve on the left, actuates it and dispenses lubricant to a bearing. The internal porting of the metering valve then permits the lubricant under supply pressure to flow to the next valve (shown discharging). The process continues from left to right until all the metering valves have been actuated. The four way valve is then turned thus venting the side of the supply line marked "A" and pressurizing the portion marked "B". The metering valves are then actuated in the reverse order, from right to left, and are returned to their initial condition.

Fig. 30 is a cutaway schematic of a typical metering valve. In Figure 30A pressurized lubricant is shown entering the valve from a supply line at the left. The supply pressure moves the check piston and both sliding valves to the right as shown in Figure 30B. This allows supply pressure to move the main or metering piston to the right thereby dispensing a measured amount of lubricant to a bearing. When the main piston travels all the way to the right, it uncovers a port which permits supply pressure to actuate the right side check piston. As shown in Figure 30C, this permits the lubricant under supply pressure to flow out of the valve on the right side and travel down the line to the next metering valve. When all the metering valves have been discharged, the direction of flow is reversed. Fig. 30D shows pressurized lubricant entering the metering valve from the right side. The sequence of piston movements again dispenses lubricant to a bearing and returns the metering valve to its initial condition.

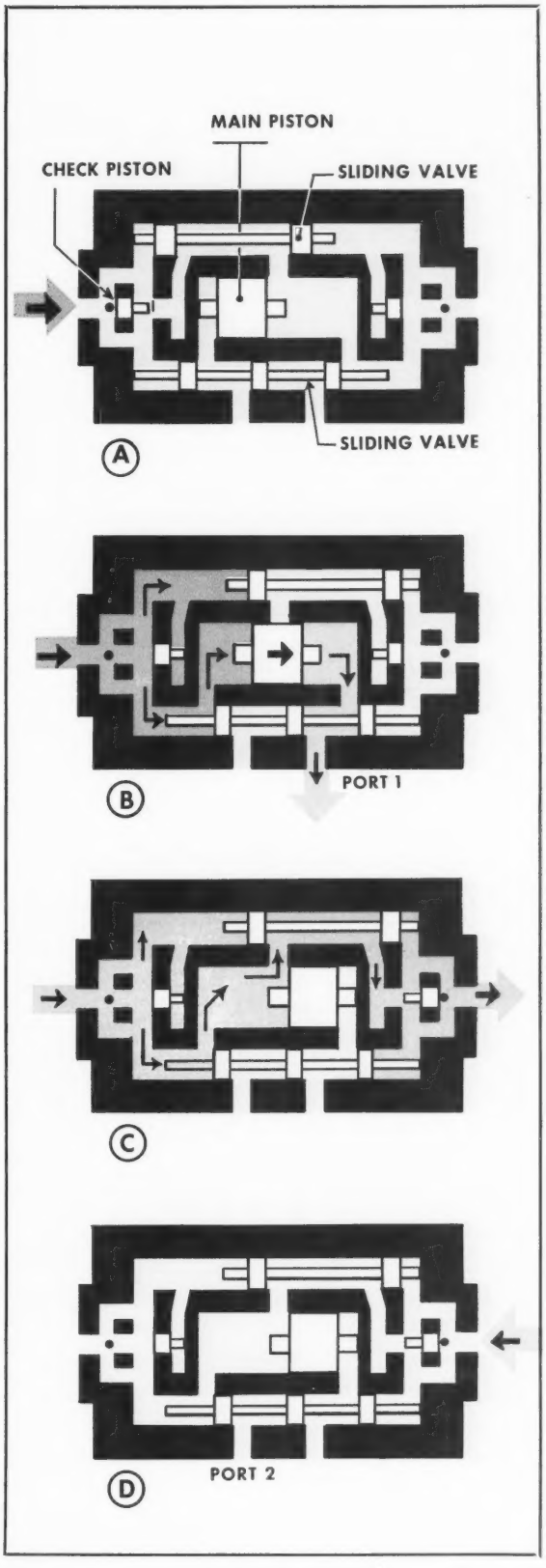


Fig. 30. Operation of Metering Valve for Use in a Series System with Reversible Flow

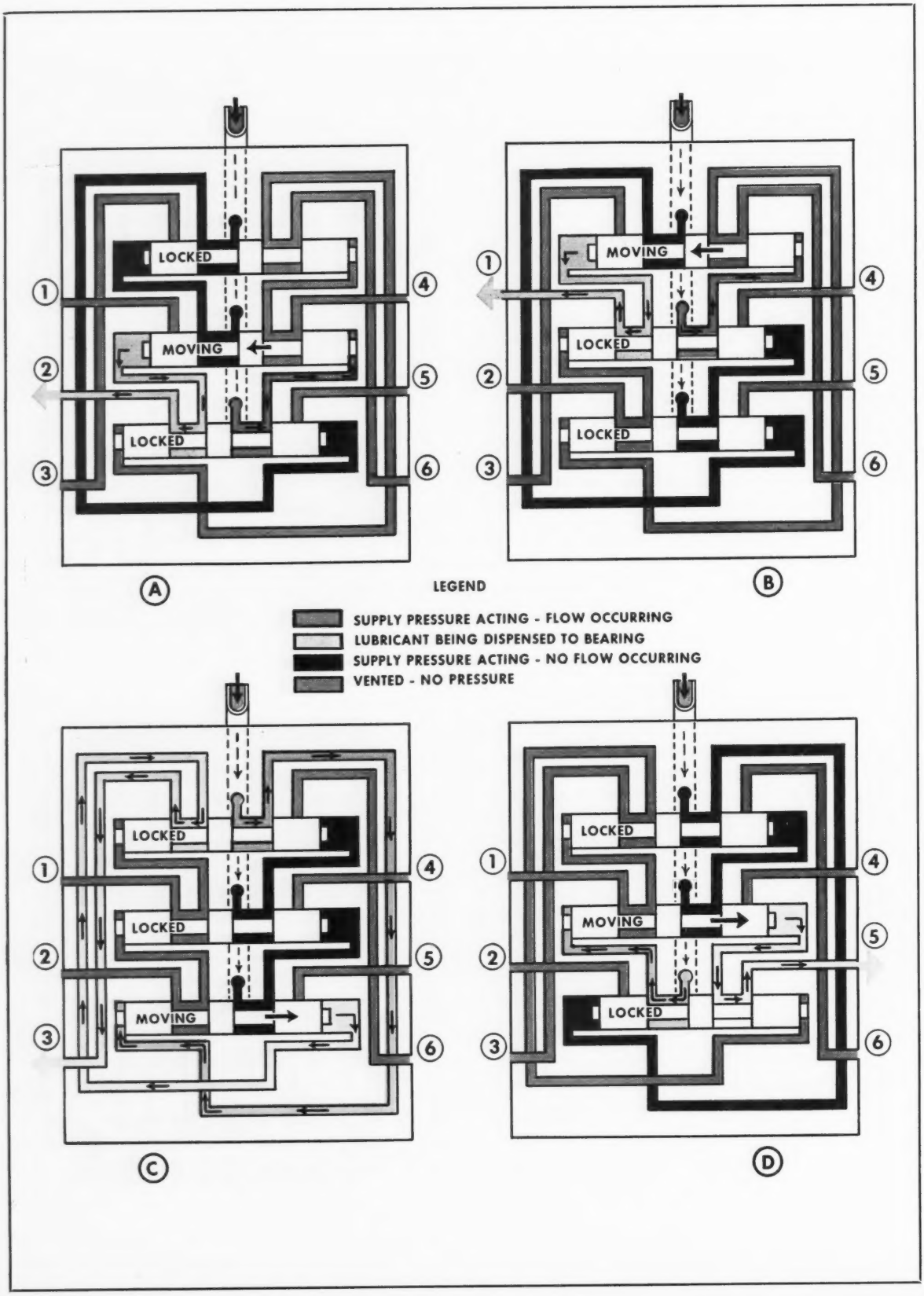


Fig 32. Operation of a typical Manifold for a Series System with Non-reversing Flow

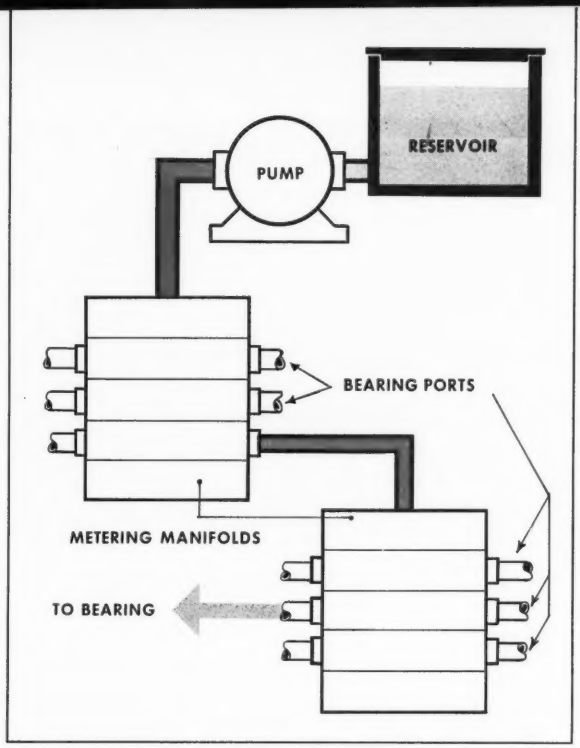


Fig. 31. Series Manifold System with Non-Reversing Flow

Series Manifold System, Non Reversing Flow:

Fig. 31 illustrates schematically the series manifold system. The pump supplies lubricant to one or a number of manifolds connected in series. Each manifold contains three or more metering pistons. As long as supply pressure acts, lubricant is dispensed to bearings in a set sequence.

Fig. 32 is a cutaway schematic of a typical manifold which, for simplicity, is shown having three pistons. In Figure 32A lubricant under pressure enters from the supply line at the top of the manifold and acts on the right hand side of the middle piston. This moves the middle piston to left thereby causing a metered amount of lubricant to be dispensed through the bearing outlet port marked "2". It should be noted that while the middle piston is moving, the internal porting arrangement distributes the supply pressure in such a manner that the other two pistons remain stationary. When the middle piston reaches the limit of its travel, as shown in Fig. 32B, it opens an internal port which permits supply pressure to act on the left side of the top piston thereby dispensing lubricant through bearing outlet port 1. When the top piston reaches the limit of its travel, Fig. 32C, it opens an internal port which allows the supply pressure to move the bottom piston to the right and dispense lubricant through bearing outlet port 3. When the bottom piston reaches the limit of its travel as shown in Fig. 32D, supply pressure then moves the middle piston to the right dispensing lubricant through bearing outlet port 5. It may be noted that the middle piston has now been returned to its initial position. The pistons continually move back and forth and lubricant is dispensed in the manner described as long as the supply pressure acts.

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Gits Bros. Mfg. Co.
Chicago 23, Illinois

Gray Co. Inc.
Minneapolis 15, Minn.

Lincoln Engineering Co.
Div. The McNeil Machine and Engineering Co.
St. Louis 20, Mo.

Lunkenheimer Company
Cincinnati 15, Ohio

Madison-Kipp Corp.
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Manzel, Unit of Houdaille Industries, Inc.
Buffalo 10, New York

McCord Corporation
Detroit 11, Michigan

Nathan Manufacturing Co.
New York City, N. Y.

National Sales, Inc.
Wichita, Kansas

C. A. Norgren Company
Englewood, Colorado

Wm. W. Nugent and Co. Inc.
Skokie, Illinois

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Alemite Marketing Div.
Chicago 14, Illinois

The Farval Corporation
Cleveland 4, Ohio

The Aro Equipment Corp.
Bryan, Ohio

Trabon Engineering Co.
Solon, Ohio

Trico Fuse Mfg. Co.
Milwaukee 12, Wisconsin

What's new in

LUBRICATING FARM MACHINERY

by John R. Brehmer
Chief Application Engineer
Alemite Division
Stewart-Warner Corp.
Chicago, Illinois

In the past three years centralized lubrication systems, offered as optional or standard equipment by the manufacturers of farm machinery, have gained wide consumer acceptance because the high initial cost and great productive capacity of modern farm equipment has made non-productive time very costly.

The systems currently employed by the farm industry were originally introduced to the public on passenger cars but found a greater market in the farm field because of their ability to eliminate the non-productive time for manual lubrication and bearing replacement. These positive displacement type centralized systems employ nylon pressure tubing as the distribution media for dispensing semi-fluid lubricants to critical and inaccessible bearing locations. Preassembly of major sections of the systems by their suppliers has readily adapted these installations to assembly line production.

Because these systems have shown an ability to withstand the severe field conditions encountered by farm equipment with a minimum of maintenance, they should enjoy increasing popularity in this market.

INTRODUCTION

Six or seven years ago the lubrication of modern farm machinery was good subject material (1,2,3) for any author whose desire for up-to-date lubrication practices was enraged by the antiquated methods employed in an otherwise fast progressing industry. Last year a paper (4) was presented at the NLGI Annual Convention summarizing the developments to date and suggesting a possible path to follow regarding the future endeavors of lubricant manufacturers. During this seven year period cartridge type hand guns have been developed and marketed successfully. Sealed bearings and synthetic "frictionless" materials have become popular devices of the product engineer, and a wide range of new lubricants have been successfully applied. Most recently the evolution of methods from barrel to bearing lubrication has progressed to bank lubrication and centralized lubrication systems.

Presented at the 16th ASLE Annual Meeting in Philadelphia, Pa., April, 1961

It can be generally said of the farm industry that most of the postwar developments did not change the basic methods of operation of farm machinery. Rather most of the design improvements considerably reduced the time and labor required to process the crops by modernizing the same fundamental principles. By increasing engine horsepower, by using hydraulics to supplement manual controls, and by increasing the efficiency of components, design engineers have not only been able to cope with the greatly increased yields per acre, but also have created machinery that will process more rows of crops at higher speeds and also perform the combined operations of two or more older machines. The capacity of this new equipment is amazing and, coupled with the factor of a larger capital investment for the farmer, has of course magnified the importance of reducing downtime for lubrication and repairs.

Only in the past three years have the manufacturers of farm machinery offered factory installed centralized lubrication systems as optional or standard equipment. Considering the recent trends in this industry that have made nonproductive time so objectionable, it is not surprising that these systems have gained wide consumer acceptance.

ORIGIN OF FARM EQUIPMENT CENTRALIZED SYSTEMS

When nylon pressure tubing was first introduced in the early fifties, the manufacturers of centralized systems were convinced this material could be employed to help overcome the barriers of cost of materials and labor required to install a centralized system on mobile equipment. While experimental work proceded concurrently on automobiles, lift trucks, trucks, and farm machinery, the first system using nylon pressure tubing was introduced to the public in 1955 on passenger cars. While it was generally successful, it did not catch much public interest because chassis lubrication was integral with many other automotive service functions. However, this first application helped tremendously to develop the application techniques necessary for the survival of these systems on farm machinery.

WHAT SYSTEMS ARE NOW OFFERED

The systems offered on farm equipment today differ considerably from the few systems installed in the period from eight to twenty years ago. Because of the small component size and small diameter tubing required to dispense the newly developed lubricants, and because of the new assembly techniques developed, the cost of these systems to the farmer varies between $3.50 and $6.00 per bearing as compared with $8.00 to $20.00 per bearing for the older systems. These older systems, still used widely in heavy industry today, were designed to handle heavy lubricants and were too bulky and hard to install of farm machinery. While these systems were functionally excellent the farmer could not afford them.

The two types of centralized systems that are most widely employed on farm equipment today are similar in many respects. These systems are capable of dispensing oils and semi-fluid and rheopectic lubricants by positive displacement metering to each individual bearing. Depending on the system employed, the quantity of lubricant per cycle can vary from .003 cubic inch to .021 cubic inch. Nylon pressure tubing is used as the principal dispensing media. This tubing is covered with vinyl, fiber, or flexible metal sleeving to provide for abrasion resistance.

Nylon pressure tubing deserves special attention since its use is directly related to the very economical cost of these systems. Most commonly used is the $\frac{1}{8}$ OD size, this tubing combines the flexibility of hose with the thin wall structural strength and coupling characteristics of copper or steel tubing. It retains all of the chemical inertness of nylon and its mechanical properties are best illustrated in the burst and proof pressure versus moisture content curves shown in Figs. 1 and 2. In most farm equipment environments, the moisture content of the tubing seems to vary between 1% and 3%.

Returning to the similarities of these systems, the pumping mechanisms employed may be actuated manually, mechanically, and by air pressure or vacuum. Finally, both of these systems are capable of developing approximately the same maximum lubricant pressure at the bearing. While most of the installations presently available rely upon the operator to determine the cycle frequency necessary to keep the bearings adequately supplied with the lubricant, several installations are available that are fully automatic.

The features that differentiate the two systems are principally related to the method by which the lubricant is dispensed to the bearings. In one system

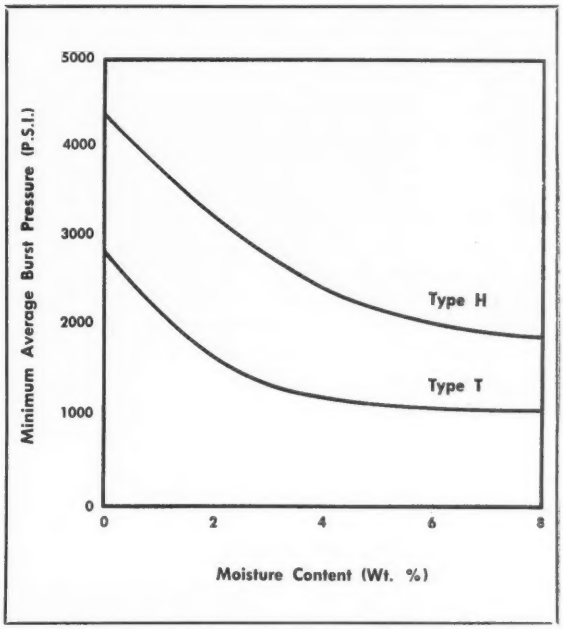

Fig. 1. Minimum Burst Pressure of Nylon Tubing at Various Moisture Contents (77 F)

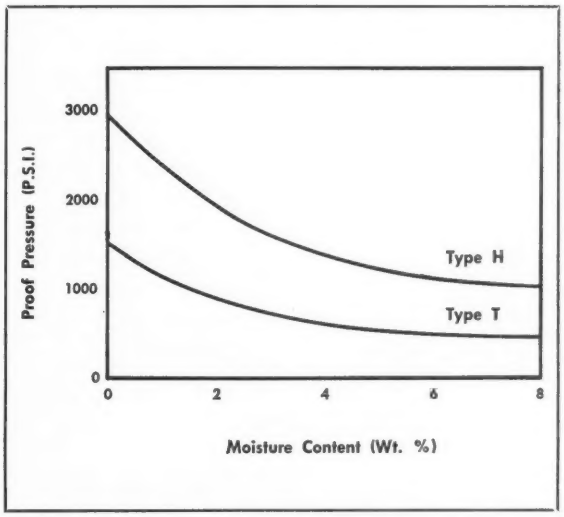

Fig. 2. Proof Pressure of Nylon Tubing at Various Moisture Contents (77 F)

the pump also acts as the metering device and separate lines are routed from outlets on the pump to each bearing (see Fig. 3).

The metering in this system is accomplished by proportioning the lubricant to each outlet in the pump as the pump piston advances. The lubricant in piston cavity is forced through the center of the piston to a cross port which progresses past each outlet port. The linear distance between these ports, located around the circumference of the pump body, determines the amount of lubricant delivered to each bearing. Refill of the pump cavity is accomplished by vacuum priming on the spring actuated return of the pump piston.

This type of system has the following advantages:

1. Plugged lines or bearings or pinched lines can be detected since the piston of the pump will hydraulically lock when no lubricant can be dispensed into a line.
2. Since the line routing to each bearing is independent of the others, a broken line to one bearing does not affect the rest of the system.
3. Also, because the routing to each bearing is independent, the pressure in each line is only that required to force the lubricant into the bearing it serves.
4. On manual systems rapid multiple cycling of the pump is possible to increase the amount of lubrication in the bearings.
5. There are no values required since the pump does the metering.

The other system is analogous to a hydraulic brake system in that a pump supplies lubricant to a distribution system that terminates with piston type measuring valves at each bearing (see Fig. 4). The pump delivers lubricant under pressure to the system and, as the pressure increases, the pistons in each of the measuring valves are forced downward by the lubricant entering the valve. The lubricant on the other side of the piston is dispensed into the bearing. When the valve piston completed its stroke it shuts off the bearing outlet of the valve. When the pressure cycle is complete the pressure in the system is relieved and the valve pistons return to their original position by spring pressure. Piston clearance in the valve is sufficient to allow the lubricant to flow around the piston on the return stroke and fill the discharge cavity for the next cycle.

The advantages of this system are as follows:

1. Since a broken line is accompanied by a pressure loss in the system, broken lines are readily detectable.
2. Because the valves measure at the bearings, a wide range of valve capacities permit each bearing to receive more or less lubricant in relation to others in the system.
3. Only one pumping mechanism is required regardless of the size of the system.
4. Various attachments with lines and valves installed can be added or removed from the machine equipped with the pump by means of a quick disconnect.

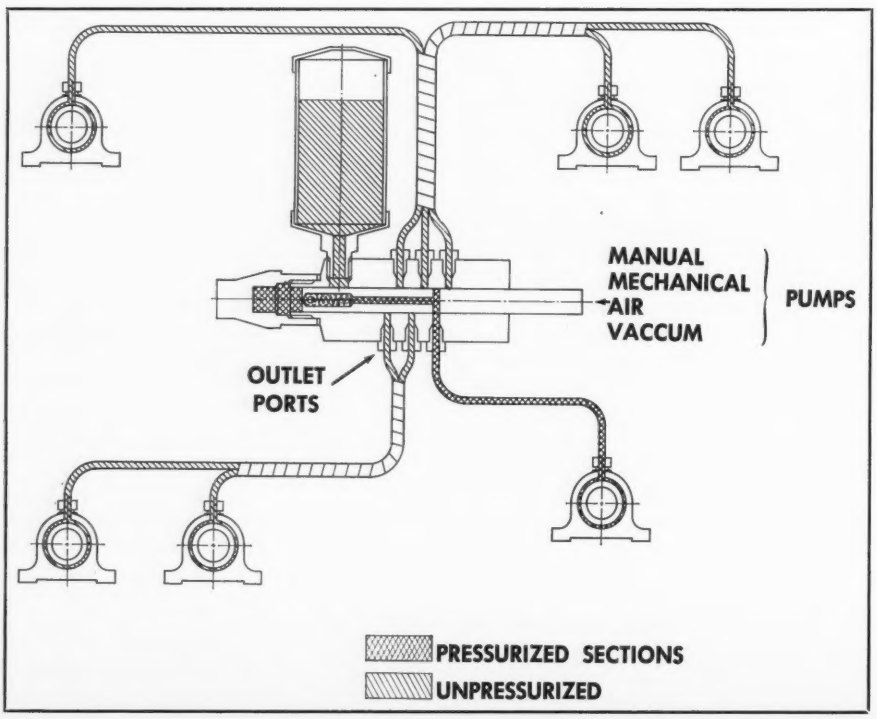

Fig. 3. Multiple Line Terminating Centralized System

5. Pump location is very flexible since only a single main line is routed from the pump to the system.

Because of the many similarities in these systems, the advantages of each are inherent mainly in their operating principles. From the author's experience it would seem that the relative successfulness of any installation is governed, more by how thoroughly the application is tailored to meet the requirements of that particular piece of equipment, than by the operational limitations imposed by the mechanics of the design. This is the primary reason why, to date, the manufacturers of the systems prefer factory installations rather than field installations by the implement dealers or farmers.

Close cooperation between the system manufacturers, the farm equipment manufacturers, and the lubricant suppliers has in great measure contributed to the success of these systems. The ultimate benefit of the system is realized by proper education of the personnel responsible for the operation and maintenance of the equipment.

TYPES OF EQUIPMENT COVERED

If one were to ask, "What machine gives the farmer the biggest lubrication headache?" the unanimous answer would probably be, "A cornpicker". Cornpickers generally have more grease fittings, many of them in inaccessible places, that must be greased in the most adverse weather conditions. One cornpicker still retains 96 fittings that must be lubricated, and since cornpicking is done in the late fall and winter seasons, it is not a pleasant job. Consequently, when the farm industry was first approached by the system manufacturers, cornpickers were among the first machines offered to the application engineers for experimental installations.

If you were to ask application engineers, "What piece of farm equipment poses the biggest problem for conversion to centralized lubrication?" the unanimous answer would probably be, "A cornpicker".

First, because of the many bearings involved the system is extensive. Second, material movement through and around the machine is severe. Third, the vibration of the machine is very intense. Fourth, several bearings are located close to the ground which, in many instances, may be a semi-frozen mud. Fifth, a few bearings, such as the lower snapping roll bearings, require vast amounts of lubricant compared with small, lightly loaded idlers that require very small quantities of lubricant. Finally, cornpickers operate through an ambient temperature range from 100 F to 0 F. This particular facet of the application meant that lubricants were required with a shear rate low enough so that they could be pumped through lines with very small inside diameters at 0 F. The same lubricant also required an apparent viscosity high enough so that the lubricant would not run out of the bearings at 100 F. Fortunately extensive efforts to develop suitable lubricants for the passenger car systems had resulted in

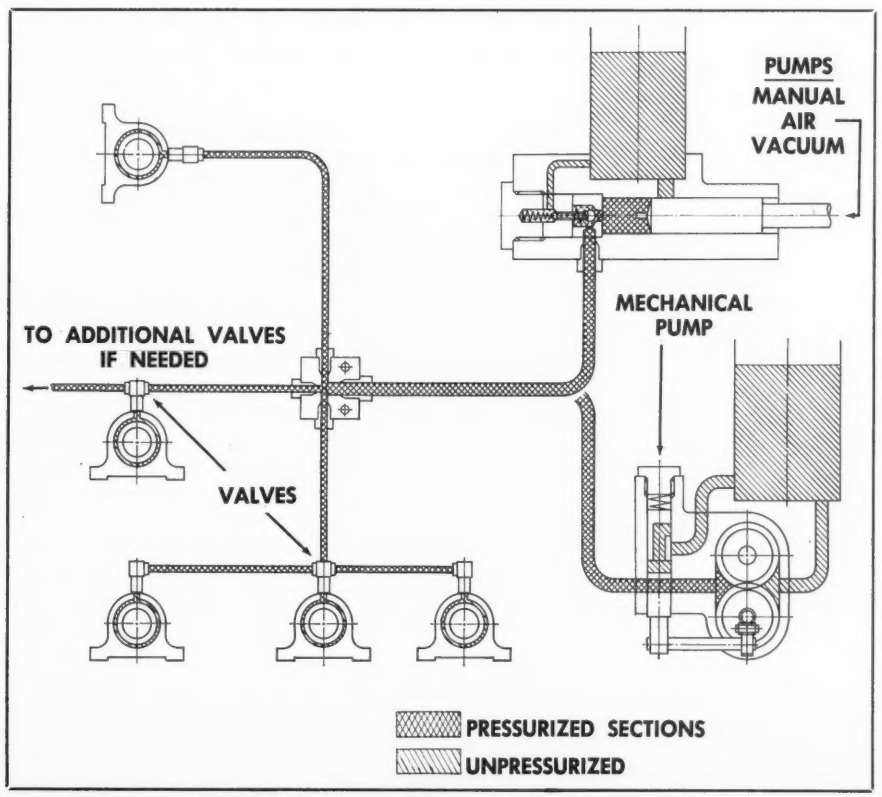

Fig. 4. Single Line Terminating Centralized System

lubricants suitable for this application (5). The most popular lubricants used in these systems today include calcium and lithium base semi-fluid greases with an 80 to 300 SSU oil and 1% to 3% soap. Some of these lubricants are rheopectic but this has not been essential.

Most of the other aforementioned problems were countered by careful routing and shielding of the lines, while the ability of the nylon tubing, when properly installed to withstand vibration throughout the ambient temperature range, eliminated the others.

After conquering the cornpicking most of the other installations were relatively simple. Today cornpickers, combines, grain drills, and hay balers are available with systems and experimental work is proceeding on many other pieces of equipment.

APPLICATION TECHNIQUES FOR MASS PRODUCTION OF CENTRALIZED SYSTEMS

Since the manufacture of all farm machinery is done on an assembly line, the problems of applying centralized lubrication systems to farm equipment not only concerned designing functional systems that would stand up in use, but also concerned designing systems that could be adapted to mass production techniques. One of the first problems encountered was that the assembly of innumerable lines, fittings, valves, etc. took too much time to assemble on a farm implement assembly line. It was estimated that in some cases the length of the assembly line would have to be increased half again to accommodate the centralized installation. This problem was solved when the manufacturers of the systems preassembled major portions of the installation into "harnesses" in a manner very similar to the handling of electrical harnesses in the automotive industry (see Fig. 5).

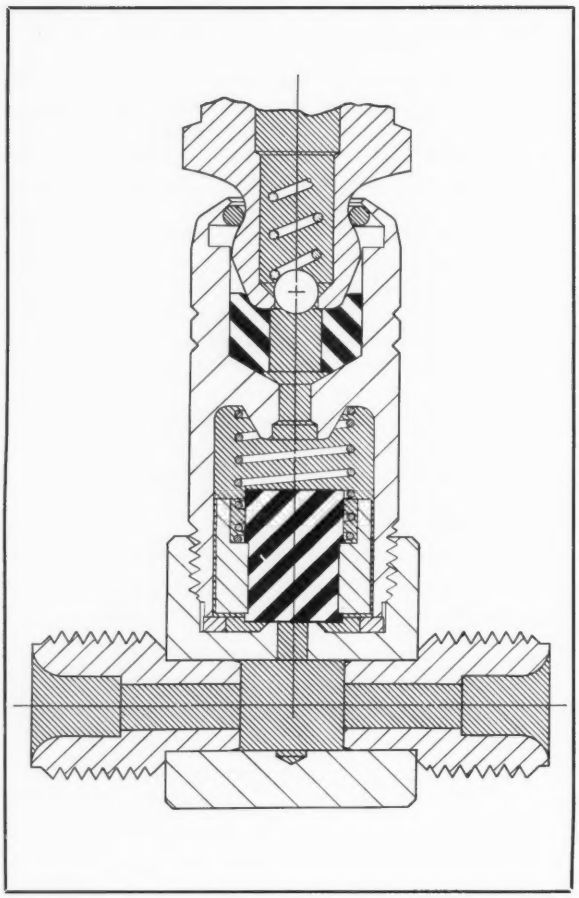

Fig. 6. Snap-on Valve and Hydraulic Fitting Assembly

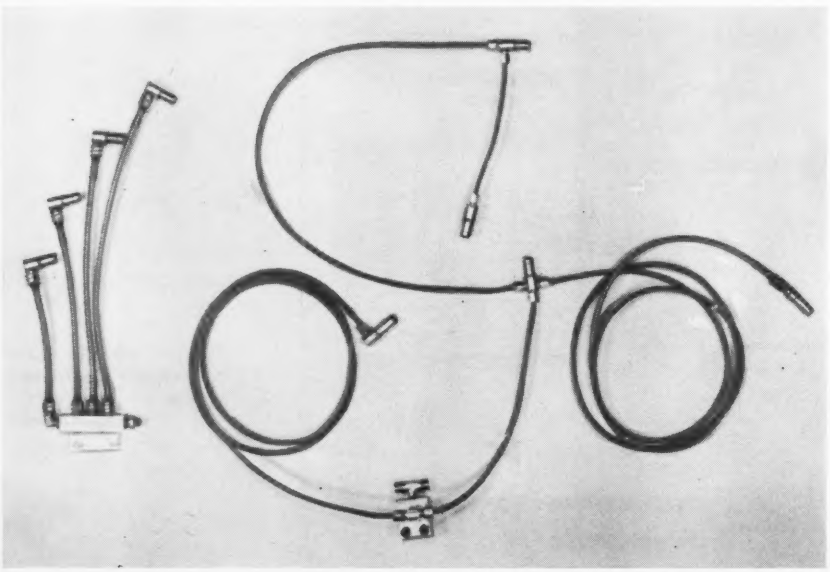

Fig. 5. Harness Assemblies

Another problem was that bearings installed on the assembly line were not filled with lubricant. The bearing cavity of large implement type rollers bearings might require as much as 2 cubic inches to fill. Since the amount discharged to a bearing in one cycle of the system is of the order of thousandths of a cubic inch, prelubrication of the bearings was considered desirable. In order to solve this problem and also further speed assembly, snap-on valves in the case of one system and snap-on adapters in the case of the other were developed that, like a hydraulic coupler, snapped over a "zerk", but unlike the hydraulic coupler, once in place formed a permanent weather tight seal (see Fig. 6).

As a result of these and other application refinements, the time required to install a system was compatible with assembly line time demands. One example is an 80 bearing fully automatic system that requires only 2 hours total installation time including subassembly operations not performed on the main production line.

SEALED BEARINGS VRS CENTRALIZED

One of the frequent questions asked when centralized lubrication is being considered for a particular piece of equipment is, "Why for the same price can't sealed bearings be employed throughout the design of the implement?" The answer to this question can probably best be stated by saying that, while some pieces of equipment are now marketed that have no bearings requiring lubrication, even the most staunch advocate of sealed bearings will admit there are practical considerations that limit their application.

One consideration is the very high cost of designing a sealed bearing into certain locations in a design. Another consideration is that should a sealed bearing failure occur in an inaccessible location, downtime for a replacement is excessive. Also the replacement of the bearing itself may be expensive. A third consideration that relates to their replacement is the demanding environment sealed bearings must live in on farm equipment. During operation these bearings are exposed to the worst possible atmospheres of dust, dirt, water, mud, and grit. Since farm operations are seasonal, these bearings must also withstand long residence time under wide fluctuations in ambient temperatures. These conditions are ideal for condensation and oxidation within the bearing. Therefore one might conclude that in critical locations the sealed bearing leaves something to be desired.

The author has also noted that in most papers offered comparing the sealed bearing with the greased bearing, no consideration is given to a greased bearing supplied by a centralized lubrication system (6). A greased bearing lubricated daily with a hand gun suffers first from severe over lubrication, especially in bank systems where the bearing may not be visible from the point of grease application. Then it suffers from border line or inadequate lubrication just prior to the next manual lubrication which must be excessive to flush out the accumulated contaminates caused by starvation. With a centralized system, not only does every bearing receive lubricant, but also receives the lubricant in a sensible manner, namely small amounts introduced at frequent intervals. This type of application does not injure seals required for a lubricated bearing but still provides enough flushing action to prohibit the entrance of contaminants.

This is not a condemnation of sealed bearings. Ideally sealed bearings and synthetic "frictionless" bearing materials are the preferred design solution since no maintenance is required. In practice, sealed bearings have a long trouble free life in many applications. These are usually the less critical bearings in a design such as chain or belt idlers and control pivots. On the other hand, while centralized systems are ideal for lubricating inaccessible, heavily loaded bearings, the cost of including many of the less critical bearings is prohibitive by virtue of their remoteness from other bearings or by having large relative motions.

The ideal approach to these considerations should probably be to achieve the balance between centralized, sealed bearings, and synthetic bearing materials that yield the lowest initial cost consistent with a design requiring no manual lubrication and a minimum of maintenance.

CONCLUSION

Perhaps two conclusions can be drawn from the enthusiastic acceptance of these systems in the farm industry. One conclusion is that these systems should enjoy increasing popularity in this market. The second conclusion is best illustrated by a statement (7) reviewing some of the gripes unloaded on the SAE in Minneapolis from operators of large trucks owned by the public utilities companies. One of the why-nots voiced was why not centralized lubrication systems built into the truck with all of the fittings and lines protected.

It might seem that if the farmer can afford to pay up to 25% additional price for a machine with manual lubrication virtually eliminated by sealed bearings and centralized lubrication in order to avoid greasing 125 fittings, it might behoove us to examine other areas in the consumer markets where renewed efforts to automate lubrication might reward those participating with new competitive advantages and increased sales volume.

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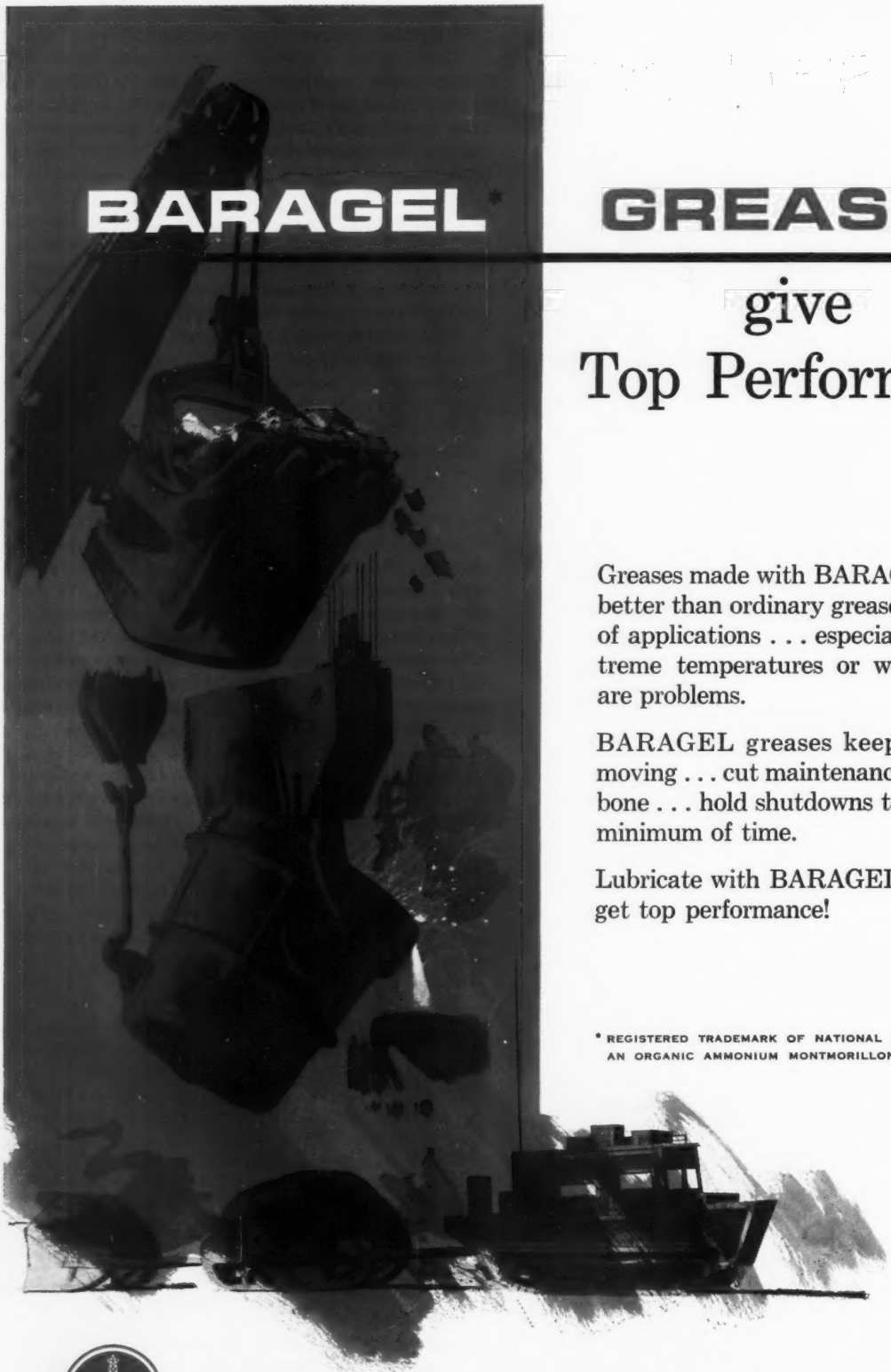

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Lubrication Abstracts

Edited by W. E. Campbell

Selected literature compiled by members of the Technical Committees and Industry Councils of the Society.

S. I. El-Sisi, "The Lubrication of Radiused-Pad Thrust Bearings", *Technica Italiana*, v. 24, no. 5, July-Aug. 1959, pp. 349-64. (In Italian). Battelle Tech. Rev. Abstracts, v. 8, n. 12, 1959, p. 715a.

An experimental investigation of the operating conditions of this type of bearing where a full convergent-divergent lubricating film exists. Load per unit width, absolute viscosity of the lubricant and surface speed are accounted for in the curves representing the experimental results. A more precise study of the local oil pressures at the "on" and "off" boundaries of the lubricant film is also included. *(Battelle Review per Edward H. Loeser)*

J. P. Perry, "Appraisal of Synthetic Lubricants in Aircraft Gas Turbines," *Canadian Aeronautical Journal*, v. 6, no. 5, May 1960, pp. 156-163.

The operation of aircraft gas turbine engines is described with emphasis on their lubricating systems, and the demands of these systems that spurred development of the ester based synthetic oils. Basic specifications for these oils, with applicable test methods, are presented. Service experience with synthetic oils, including compatibility problems, is discussed. The economics of using synthetic oils is briefly summarized, including reclamation. The author concludes with a discussion of immediate and future lubrication requirements in the aircraft gas turbine field. *(Abstractor: George C. Lawrason)*

B. Sternlicht (General Electric Company, Schenectady, New York), J. C. Reid, Jr., and E. B.. Arwas, "Review of Propeller Shaft Thrust Bearings". *Journal of the American Society of Naval Engineers, Inc.*, v. 71, 1959, pp. 277-289.

The use of thrust bearings in marine propulsion systems is unique in many respects. In particular, load and speed conditions that occur during certain ship maneuvers, and flexibility of the bearing support structure complicate their design. When space and weight considerations are added, it becomes evident that optimizing the bearing configuration is essential. This paper illustrates the effects of maneuver conditions in terms of thrust load as a function of time and the effect of load changes on oil film thickness as a function of time. The principle causes of bearing failure in marine thrust bearings are (1) poor lubrication, (2) excessive bearing temperatures, (3) dirt, under conditions of small oil film thickness, (4) fatigue of the babbitt to steel bond, (5) wiping due to reduction of hydrodynamic film pressure caused by thermal and mechanical distortions. In considering methods to optimize the bearing design to decrease the sensitivity to various modes of failure, the importance of minimizing deformations due to thermal gradients and load is emphasized. An example of optimization of a thrust bearing design using an analysis that requires the simultaneous solution of the Reynolds and Energy Equations is presented. When energy considerations are taken into account bearing failures that occur at apparently safe values of oil film thickness are often explained as the result of babbitt softening caused by localized high temperature at the bearing interface. Another important consideration with respect to the dynamic load conditions in marine applications is the role of the "squeeze film" effect in averting bearing contact and failure. *(Abstractor: H. Apkarian)*

"Film Geometry Effects in Hydrodynamic Gear Lubrication." J. F. Osterle (Carnegie Institute of Technology, Pittsburgh, Pa.), Wear-Usure-Verschleiss v. 2, no. 6, 1959, 416-22.

To facilitate analysis of the pressure distribution in the lubricant film between gear teeth it has been customary to develop the mathematical treatment using parabolic arcs as substitutes for the actual tooth profiles. It is the author's purpose to investigate the extent and importance of the error in calculated load capacity that ensues from this simplification. The effect is found to be generally negligible at high loads, when other effects such as viscosity variation, tooth deformation, etc., are greatest. A first order correction to the conventional parabolic arc film thickness equation is developed and integrated numerically on an IBM650 computer for 20° pressure angle, three oil film thicknesses, and a range of gear ratios. The correction increases the maximum pressure and the load capacity when the pinion is driving, and vice versa. *(Abstractor: E. A. Ryder)*

Patent Abstracts

Compiled by Ann Burchick
Aluminum Co. of America

Lubricant Composition, Patent No. 2,945,-814 (P. W. B. Semmens and J. D. Summers-Smith, assignors to Imperial Chemical Industries Ltd.) A boundary lubricant selected from the group consisting of lubricant compositions consisting essentially of between about 3 and 80% cetyl trimethyl ammonium dihydrogen orthophosphate dissolved in mineral oil, between about 3 and 80% of di(cetyl trimethyl ammonium) monohydrogen orthophosphate dissolved in mineral oil, between about 3 and 80% cetyl trimethyl ammonium dihydrogen orthophosphate dispersed in petroleum jelly, between about 3 and 80% di(cetyl trimethyl ammonium) monohydrogen orthophosphate dispersed in petroleum jelly, and between about 3 and 80% di(cetyl pyridinium) monohydrogen orthophosphate dissolved in castor oil.

Lubricant Additive, Patent No. 2,956,953 (W. B. Whitney, assignor to Phillips Petroleum Co.) A process for producing a material having detergent and dispersant properties which comprises subjecting a propane-fractionated, solvent-extracted hydrocarbon fraction containing at least 40 carbon atoms per molecule and having a viscosity of at least 58 SUS at 210 F. to oxidation in the presence of nitric acid containing from 60 to 100 weight percent HNO_3 at a pressure of from atmospheric to 50 p.s.i.g. and a temperature of 400 to 600 F. for a period of time in the range of 1 second to 5 minutes.

Synthetic Ester Lubricants, Patent No. 2,-956,954 (M. F. Hoare and B. T. Fowler and H. G. Krischai, assignors to Esso Research and Engineering Co.) An improved synthetic ester lubricant, having a kinematic viscosity at 210 F. of more than 6.5 cs. and less than 150 SSU at 210 F., and consisting essentially of a mixture of a complex ester and diester prepared by combining more than two mols each of a dicarboxylic acid and an aliphatic monohydric alcohol per mol of polyglycol.

Stabilization of Lubricating Oils in the Presence of a Nickel-Alumina Catalyst and Hydrogen, Patent No. 2,946,743 (J. A. E. Moy and A. A. Yeo, assignors to The British Petroleum Co. Ltd.) A method of treating a lubricating oil to improve its color and oxidation stability comprising contacting the oil in the presence of hydrogen at a temperature of 150 to 430 C. and a pressure of 50 to 800 p.s.i.g. with a catalyst, said catalyst being a nickel-alumina base impregnated with nickel, said catalyst having been prepared by impregnating aluminum oxide with a solution of a nickel compound, said nickel compound being decomposable under heat to the nickel oxide thereof, roasting the impregnated aluminum oxide at a temperature above 650 C. to form said nickel-alumina base, impregnating said nickel-alumina base with a solution of a nickel compound, said nickel compound being decomposable under heat to the oxide thereof, and roasting the impregnated nickel-alumina base at a temperature of 350 to 650 C. to obtain said nickel-alumina base impregnated with nickel.

Continuous Grease Manufacture Using Coated Free-Flowing Alkali Metal Saponifying Agent, Patent No. 2,946,751 (A. Beerbower and W. H. Meyer, assignors to Esso Research & Engineering Co.) In a process for preparing a lubricating grease composition, comprising feeding an alkali metal base to a mixing zone, simultaneously feeding a lubricating oil dispersant to said mixing zone to obtain an alkali metal base oil slurry, mixing said slurry with additional lubricating oil dispersant and a grease-thickening proportion of a saponifiable material, heating the resulting mixture to a grease-forming temperature, dehydrating and then cooling to obtain said lubricating grease composition, the improvement which comprises maintaining said alkali metal base free-flowing by thoroughly mixing it with a dry, alkaline earth metal base powder sufficient in amount to coat said alkali metal base.

Metal Drawing Lubricant, Patent No. 2,947,692 (E. C. Hughes and H. M. Stine, assignors to The Standard Oil Co.) An emulsifiable lubricating composition comprising 60 to 75% by weight of a suspended phase consisting essentially of about 85 to 97% by weight of an inert solid material selected from the group consisting of calcium carbonate, zinc sulfide, lithophone, and talc having a hardness of 1 to 3.5 on Mohs' scale and a particle size at least fine enough to pass a 150 mesh screen and about 3 to 15% by weight of hydrophilic bentonite, and from about 40 to 25% by weight of a suspending phase consisting essentially of about 50 to 88% by weight of a mineral lubricating oil having a viscosity within the range of about 50 to about 500 SUS at 100 F. and about 12 to 50% by weight of an emulsifying agent of the oil-in-water type.

Oil Compositions Containing Metal Salts of Ricinoleate Dithiophosphoric Acids, Patent No. 2,947,693 (J. M. Boyle, C. S. Lynch and H. R. Ready, assignors to Esso Research & Engineering Co.) A lubricating oil composition comprising a major proportion of lubricating oil and about 0.01 to 10% by weight of a compound.

Lubricating Oil Additives Comprising Mixtures of Polyvalent Metal Dithiocarbamates, Patent No. 2,947,695 (R. Leshin and J. G. Lichty, assignors to The Goodyear Tire & Rubber Co.) A lubricating oil additive composition consisting of a petroleum hydrocarbon lubricating oil solution of a mixture of at least two different dithiocarbamates.

Drawing Lubricant, Patent No. 2,958,659 (L. J. Brown, assignor to Pennsalt Chemicals Corp.) A drawing lubricant for application to metal stock from admixture with water consisting essentially of from 15 to 45% by weight fatty acid soap, a metal borate, and from 0.75 to 2.0% by weight of the solid materials of a polyethylene glycol having a molecular weight of at least 1000.

(*Continued on page* 399)

PATENT ABSTRACTS

(*Continued from page* 398)

Detergent and Wear Inhibiting Mineral Mineral Lubricating Oil Compositions, Patent No. 2,958,660 (J. A. Edgar and R. F. Bergstrom and R. C. Jones, assignors to Shell Oil Co.) A lubricating oil composition comprising a major amount of mineral lubricating oil and a minor but detergent amount of an oil-soluble copolymer of an acrylate ester of an acrylic acid and a long chain aliphatic alcohol and a vinyl pyridine in the mol ratio of 1:1 to 10:1 respectively and having a molecular weight of from 50,000 to 700,000 and a minor, but wear inhibiting amount of an oil-soluble basic alkaline earth metal petroleum sulfonate containing from 50% to 800% excess base.

Lubricating Compositions, Patent No. 2,958,661 (T. E. Reamer and J. E. Weigel, assignors to Shell Oil Co.) An aqueous metal working lubricant comprising a major amount of water and from about 1% to about 10% by weight of water soluble tri-alkali metal salt of a mercaptodicarboxylic acid wherein the mercapto radical is attached to a carbon atom selected from the group consisting of carbon atoms which are in the alpha and beta positions to a carboxyl group and from about 1% to about 10% by weight of a water-miscible hetero-copolymer of ethylene oxide and 1,2-propylene oxide wherein the ethylene oxide and 1,2-propylene oxide are combined in the weight ratio of 75:25 to 10:90, respectively, and wherein the copolymer has a molecular weight of from about 250 to 1500.

Grease Composition Thickened with a Metal N-Substituted Carbamate, Patent No. 2,957,826 (T. W. Martinek, assignor to The Pure Oil Co.) A method of preparing a metal N-substituted carbamate-thickened grease which comprises reacting a dispersion of a finely-divided metal of the group consisting of alkali and alkaline earth metals, aluminum, tin, and lead, in an oleaginous lubricating liquid of lubricating viscosity with sufficient CO_2 and R_2NH, where R is of the group consisting of hydrogen and C_1-C_{30} alkyl and aralkyl radicals, at least one R being a C_1-C_{30} radical, to form a metal N-substituted carbamate salt in situ and produce a grease.

Lubricating Oil Compositions Containing Bi-Metal Dithiophosphates, Patent No. 2,945,810 (J. H. Walker, assignor to California Research Corp.) A lubricating oil composition comprising a major proportion of a mineral lubricating oil, and from about 0.25% to about 20%, by weight, of a bimetal salt of a dithiophosphoric acid, wherein said bi-metal salt is prepared by reacting barium oxide with a zinc salt of a diester of dithiophosphoric acid.

Functional Fluids, Patent No. 2,944,976 (E. E. Waters, J. J. Shatynski and J. E. Koch, Jr., assignors to Celanese Corp. of America) A fire-resistant hydraulic fluid comprising a homogeneous mixture of from 40 to 60% of water, about 15 to 45% of a glycol, and about 15 to 45% of a polyoxyethylene ether of castor oil, said polyoxyethylene ether containing at least sufficient ethylene oxide units to make it water-soluble.

Thickened Lubricant and Process for Preparing the Same, Patent No. 2,945,809 (E. C. Milberger, assignor to The Standard Oil Co.) A thickened lubricant of good temperature susceptibility properties, consisting essentially of (1) a mineral lubricating oil of lubricating viscosity as the major component and (2) as the minor component a silica aerogel thickening agent in an amount sufficient to impart a grease consistency to the oil, said silica aerogel having been prepared from a hydrogel containing from 3 to about 8% SiO_2 by converting the hydrogel into an alcogel, volatilizing liquid contained in the alcogel to form an aerogel by heating at a temperature and pressure above the critical temperature and pressure of alcohol in the alcogel to convert the alcohol into a gas without destroying the gel structure, devolatilizing the aerogel by heating at a temperature of from about 1200 to about 1800 F. and then reducing the devolatilized aerogel to a secondary agglomerate particle size of from one to six microns.

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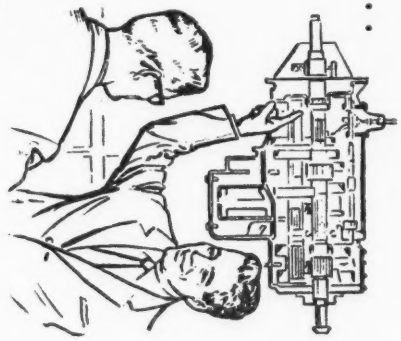

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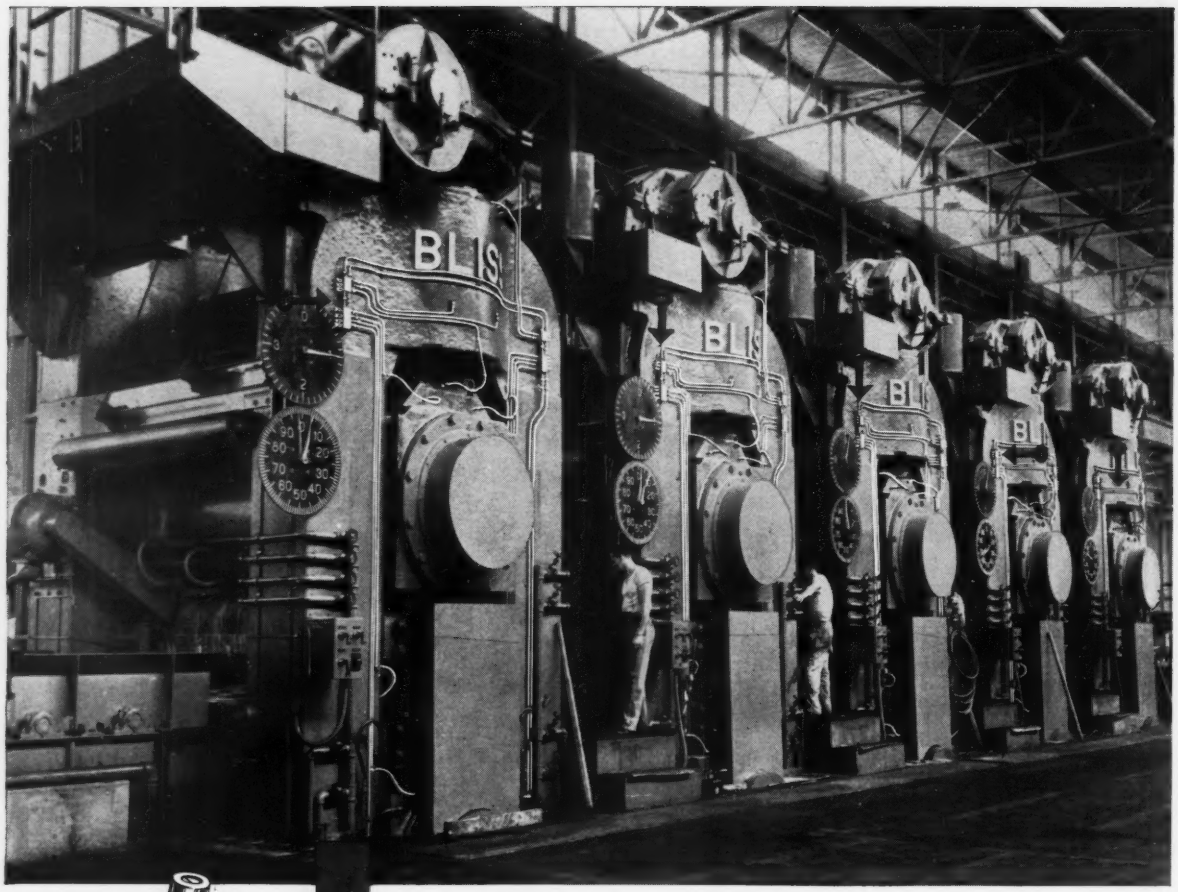

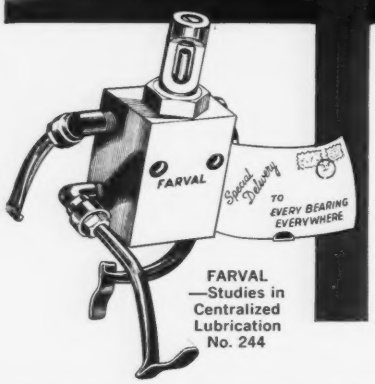

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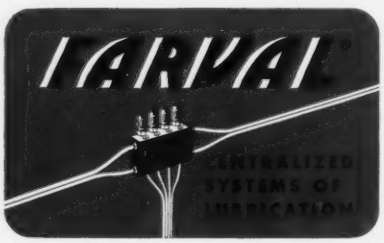
When an up-to-the-minute rolling facility like this Bliss 80-inch, 4-high tandem hot mill is exposed to shut down due to bearing failure, weekly production dives, costs skyrocket.

So to eliminate possible failures of the mill's vital bearings, Bliss engineers installed an automatic Farval heavy-duty, time-clock controlled centralized lubrication system. It delivers proper amounts of lubricant — when required — while the mill rolls aluminum strip at 850 feet per minute.

Write today for your free copy of Bulletin 26-T. It gives all the facts on how centralized lubrication can profitably fit into your particular production picture.

Farval Division • Eaton Manufacturing Company
3282 East 80th Street • Cleveland 4, Ohio

KEYS TO ADEQUATE LUBRICATION

Wherever you see the sign of Farval—familiar valve manifolds, dual lubricant lines and pump stations —you know rolling mill equipment is being properly lubricated.

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